A method for evaluating the effectiveness of medications prescribed for Intention Tremor in Patients with Multiple Sclerosis

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Abstract

In this paper we describe a method for evaluating the degree of intention tremor in the upper limb in patients with Multiple Sclerosis, based on kinematic analysis of visually guided reaching movements using a digitizing tablet and a two-dimensional accelerometer attached to the forearm. The method provides room for deriving indicators of tremor degree and demonstrates the possibility for a promising sensitivity to detect slight changes in tremor level upon the conduction of treatment\managemnt protocls, which might be very difficult to be detected by conventional clinical measures or by the observations of the patients' Activities of Daily Life.

1 Introduction

Tremor is an involuntary rhythmic oscillatory movement of a body part and can be severely disabling and extremely difficult to treat [1][2]. Intention Tremor (IT) is one type of Kinetic tremor (tremor occuring during any voluntary movement) that is charatcterisied by the increase of tremor amplitude during visually-guided movements toward a target at the termination of the movement [1][2][3]. Intention Tremor has been described in Multiple Sclerosis (MS) and observed to appear embedded in a complex movement disorder, which often includes some ataxic features [2][3]. One challenge with MS subjects is to be able to distinguish between kinetic tremor and other symptoms (e.g. ataxia). Tremor is common in MS; it has been reported to occur in more than half of all the patients suffering from MS as a significant diabling symptom [2][3]. One major difficulty experienced when it comes to evaluating tremor in MS, in addition to the challenge of distinguishing it from other ataxic features, is the lack for robust, reliable indicators to quantify tremor in levels or degrees, and to be sensitive enough to detect small changes of this level, which can be of great aid for clinicians in persuing a tremor-management protocol and thus in evaluating the effectiveness of such plans in improving the Activities of Daily Life (ADL) of the patient.

2 Materials and Methods

2.1 Subjects

We tested a total of 9 subjects with definite MS on both of their arms (18 arms). Nine arms (1 left and 8 right) for 9 subjects with no evidence or previous history of neurological disorders were taken as controls. MS subjects arms were classified into 3 categories, based on their score of Kinetic Tremor, Rating Scale (KTRS) which also includes the Intention tremor component: (i) ABSENT-KT: (KTRS=0; n=8 arms in 4 subjects, average EDSS=3.75); (ii) MODERATE-KT: (KTRS=2,3, n=6 arms in 4 subjects, average EDSS=5.5); (iii) SEVERE-KT: (KTRS=4, n=4 arms in 3 subjects, average EDSS=6.2).

2.2 Experimental Set-up and Task

A data acquisition system was developed, which acquires two-dimensional hand position from a standard digitizing tablet. Subjects are instructed to perform a reaching task consisting of planar movements performed with both arms (amplitude 10 cm) toward targets in one among 8 different directions on a horizontal plane, presented in random order, under two different conditions: (i) VISION: subjects could see the instant position of their own hand on a computer screen; and (ii) NO VISION: hand position was not displayed. Trajectories were recorded at 125 Hz by the tablet. A two-dimensional accelerometer was attached to the subject's forearm to provide additional information on arm acceleration.

2.3 Data analysis

Movement trajectories were smoothed (4^{th} order Savitzky-Golay with a 220 ms window, equivalent cut-off frequency: 7 Hz), and the same filter was used to estimate speed, acceleration and jerk. We then estimated the centripetal component of acceleration (i.e., the one responsible for lateral deviations from the current trajectory), and estimated its power spectral density. We then calculated the following indicators: (i) PSD magnitude in the 3-7 Hz range; (ii) median PSD frequency; and (iii) range (standard deviation) of the centripetal acceleration signal along each trajectory. We looked at the correlation of the tremor indicators with the clinical tremor score.

3 Results

Preliminary results verify clinical assessment in terms of identifying tremor and non-tremor subjects within the group of the study. Moreover, the observed range of centripetal acceleration shows a significant correlation with the clinical tremor score; our indicators clearly distinguish among the three categories mentioned above. Thus, they provide the possibility to quantitatively assess kinetic tremor in MS and to study the in-coordination involved as well as the interplay between kinetic tremor and visuomotor coordination. As regards the dependence on vision, our indicators appeared to be lower in the NO-VISION condition. Figure 1 shows an example of one tremor indicator established here, based on the centripetal acceleration component of the arm movement of a tremor patient. Figure 2 shows the corresponding result for a control subject. Difference in magnitude of tremor between the two subjects is well demonstrated as well as the dependence of this magnitude on the direction of the movement.

4 Conclusions and Discussion

We have proposed and tested a method for quantitative assessment of kinetic tremor that is based on kinematic measurement in a visuomotor reaching task. The same task provides indications on the degree of in-coordination, and one challenge with MS subjects is to be able to distinguish among these symptoms. We found that our indicators indeed solve this issue by pointing tremor degree. The dependence of the magnitude of kinetic tremor on the direction of movement may be related to the anisotropy of arm inertia and stiffness. The finding that the lack of vision of the hand during movement can reduce the amount of tremor is related to previous reports that tremor is affected by the required accuracy. That, taken together, suggests that kinetic tremor may be affected by visual feedback. Future clinical application of the proposed method might be foreseen as it may provide a tool for clinicians to detect and evaluate any activity of anti-tremor treatment protocol, including the assessment of the effectiveness of medications prescribed to manage daily life activities under the condition of tremor in MS.

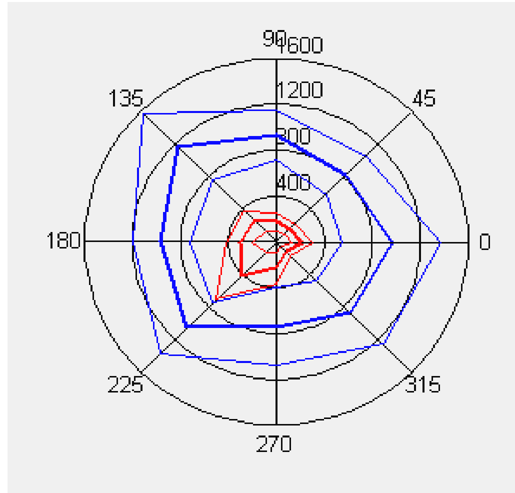

Fig. 1 Plot of Tremor Indicator based on Centripetal Acceleration for a tremor patient, representing the movement performed in 4 experiments (2 with Vision, 2 No-Vision), repeated 5 times each for 8 directions of movement.

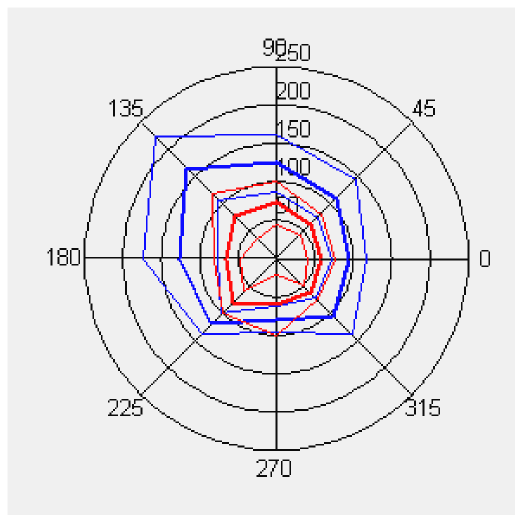

Fig. 2 Plot of Tremor Indicator based on Centripetal Acceleration for a Control subject, representing the movement performed in 4 experiments (2 with Vision, 2 No-Vision), repeated 5 times each for 8 directions of movement.

5 Literature

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