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*EMG and Acceleration Measurements
for the Differential Diagnosis of Tremor – Conceptual
Evaluation of a Quantitative Clinical Measurement Protocol*

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EMG AND ACCELERATION MEASUREMENTS FOR THE DIFFERENTIAL DIAGNOSIS OF TREMOR – CONCEPTUAL EVALUATION OF A QUANTITATIVE CLINICAL MEASUREMENT PROTOCOL

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INTRODUCTION

Frequency analysis of accelerometer signals has successfully been used to document and classify tremor types in clinical practice (1). The parallel detection muscle innervation of involved muscle groups adds beneficial information to the differential diagnosis of tremor types. Surface EMG recordings of e.g. forearm flexors and extensors allow an easy investigation of agonist-antagonist patterns within varying test positions.

METHOD

An eight channel EMG amplifier (TELEMYO 2400 - NORAXON INC.) was used to detect the surface EMG signals from the flexor carpi radialis and extensor carpi radialis group. The raw EMG signals were recorded with dual silver-silver chloride electrodes (inter electrode distance 2 cm) at 1500 Hz sampling rate. A two dimensional 1G accelerometer (NORAXON INC) was mounted on the back of the hand by using a special fixation velcro strap (Y axis = gravity line, Z axis = horizontal line) and recorded at the same sampling speed. A digital video was recorded in time synchronization to allow a full documentation of each test activity. The raw EMG signal is documented within an analysis report to allow visual inspection of the recording quality. For the co-activation analysis the raw EMG was full-wave rectified and smoothed with a Root Mean Square (RMS) of 100 ms.

TEST PROCEDURES

To establish a clinical meaningful but easy to use test protocol in a pilot study design (N=3), we programmed a test sequence consisting of 3 major activities:

Rest– patient arm is in rest position on his thighs.

Hold– patient holds both arms in horizontal extension position

Reach – patient moves his finger from thigh to the nose

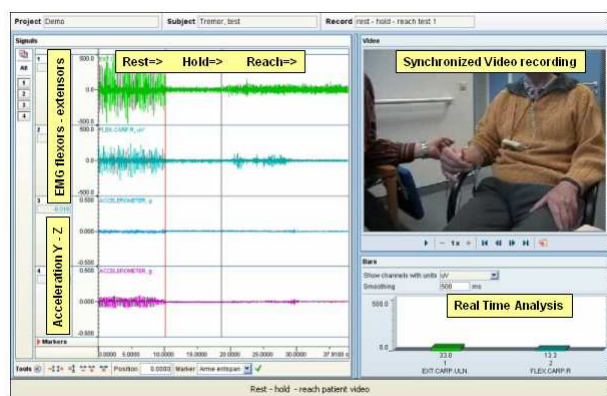


Fig. 1: Combined recording of 2D accelerometer (lower two traces) and 2 EMG traces (upper traces) with synchronized DV-video

(EMG processing and analysis software MyoResearch XP). An automatic analysis report calculates the key parameters as explained in more detail below. It may be suitable to add more activities to the protocol routine, which can be operated by a “free to configure” activity protocol. The standardized sequence is fully guided by an electronic protocol assistant and allows an easy and quick operation.

ANALYSIS REPORT

The analysis concept is based on a PC based replay and review function which allows a post hoc inspection both of the video and raw signal recordings. This approach allows a qualitative

inspection of motion specific aspects with testing. The analysis report calculates the frequency contents of both accelerometer signals by means of Fast Fourier Transformation (FFT) and documents the power spectrum around the center frequency. The peak value of the power spectrum is considered as the main tremor analysis parameter, typically ranging from 1 to 15 Hz.

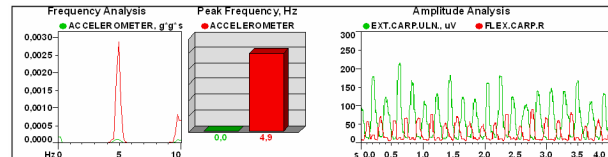


Fig. 2: FFT based frequency analysis of accelerometer signals and RMS innervation patterns for a “Rest”- activity – identifying a rest tremor with center frequency of 4.9 Hz

The RMS amplitude analysis is based on a curve overlay of both muscle traces. This graphical presentation allows for an easy detection of agonist or antagonist tremor activation and illustrates the co-activation patterns of involved muscles.

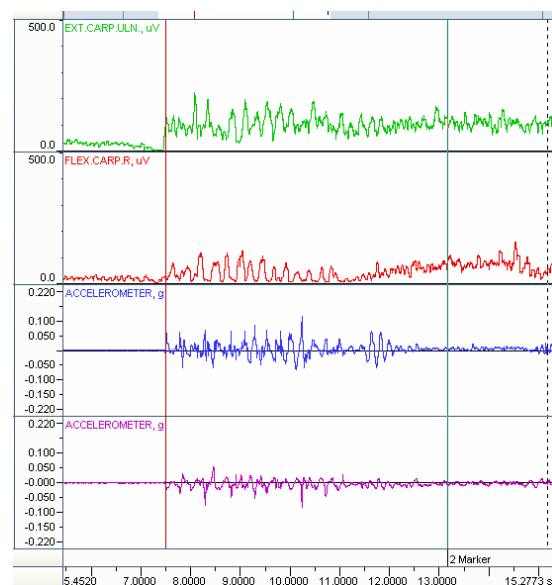


Fig. 3: Free protocol examining the water glass pouring exercise

CONCLUSION

First test runs proved a high clinical evidence by combining surface EMG recording with the accelerometer based motion parameter. The combination of a base test “Rest-Hold-Reach” with additional user configured activities like writing tasks, emptying a glass of water or bilateral activities allows for a meaningful use of the PC assisted automatic protocols. The quantitative analysis of tremor types adds important information to the classical clinical diagnosis of tremor. An algorithm to quantify the amount of co-activation still needs to be implemented in the concept.

REFERENCES

Deuschl G, Bain P, Brin M; Scientific-Committee. Consensus statement of the Movement Disorder Society on Tremor. *Mov. Disord.* 1998; 13; 2-2