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Tremor and Other Hyperkinetic Movements

Teaching NeuroImages

Characterizing Orthostatic Tremor Using a Smartphone Application

Arjun Balachandar[1] & Alfonso Fasano[2,3]*

[1] University of Toronto Medical School, Toronto, Ontario, Canada, [2] Morton and Gloria Shulman Movement Disorders Centre and the Edmond J. Safra Program in Parkinson's Disease, Toronto Western Hospital, UHN, Division of Neurology, University of Toronto, Toronto, Ontario, Canada, [3] Krembil Research Institute, Toronto, Ontario, Canada

Abstract

Background: Orthostatic tremor is one of the few tremor conditions requiring an electromyogram for definitive diagnosis since leg tremor might not be visible to the naked eye.

Phenomenology Shown: An iOS application (iSeismometer, ObjectGraph LLC, New York) using an Apple iPhone 5 (Cupertino, CA, USA) inserted into the patient's sock detected a tremor with a frequency of 16.4 Hz on both legs.

Educational Value: The rapid and straightforward accelerometer-based recordings accomplished in this patient demonstrate the ease with which quantitative analysis of orthostatic tremor can be conducted and, importantly, demonstrates the potential application of this approach in the assessment of any lower limb tremor.

Keywords: Accelerometer, diagnosis, orthostatic tremor, smartphone, wearable

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*To whom correspondence should be addressed. E-mail: alfonso.fasano@uhn.ca

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Ethics Statement: All patients that appear on video have provided written informed consent; authorization for the videotaping and for publication of the videotape was provided.

Orthostatic tremor (OT) is an involuntary movement characterized by unsteadiness during stance caused by high-frequency tremor of the lower limbs only present upon standing.[1] OT is associated with a pathognomonic frequency range, where electromyogram (EMG) of leg muscles typically shows a 13–18 Hz burst pattern.[1] Since the tremor might not be visible to the naked eye, OT is one of the few tremor conditions requiring an EMG for definitive diagnosis.[1] Some physicians adopt a stethoscope over the calf muscles looking for the "helicopter sign" but its value in clinical practice is still debated.[2]

A 72-year-old female with OT associated with parkinsonism came to our attention because of tremor affecting her left hand and unsteadiness because of an "earthquake" affecting her legs. Her tremor started 3 years earlier and worsened after general anesthesia and spinal surgery for right sciatica. Multiple medication trials did not provide any appreciable effect on her tremor. There was no known family history of tremor. On examination, she had a cautious gait with a wide base and difficulty with tandem gait, a variable tremor at rest of the left hand, a mild-amplitude action tremor affecting both hands (greater on the left), and a subtler tremor symmetrically affecting both legs during standing (Video 1). Unsteadiness because of leg tremor improved with walking, and even more so when running. When the patient was lifted, she reported having no feeling of tremor.

Tremor recordings were collected using an iOS application (iSeismometer, ObjectGraph LLC) using an Apple iPhone 5 (Cupertino, CA, USA) inserted into the patient's sock (Figure 1). Fast Fourier transform analyzing 1,024 samples detected a tremor with a frequency of 16.4 Hz on both legs (Figure 1). The same application detected a left-hand tremor at rest of 5.9 Hz.

EMG can be used to objectively and accurately detect tremor oscillations but it takes some time and requires specific equipment.

Video 1. Video of the OT Patient. On examination, the patient experienced a variable tremor at rest of the left hand and bilateral action tremor. When standing she reported unsteadiness and a subtle symmetrical tremor in both legs was observed. This tremor decreased when the patient was walking, and even more so when running.

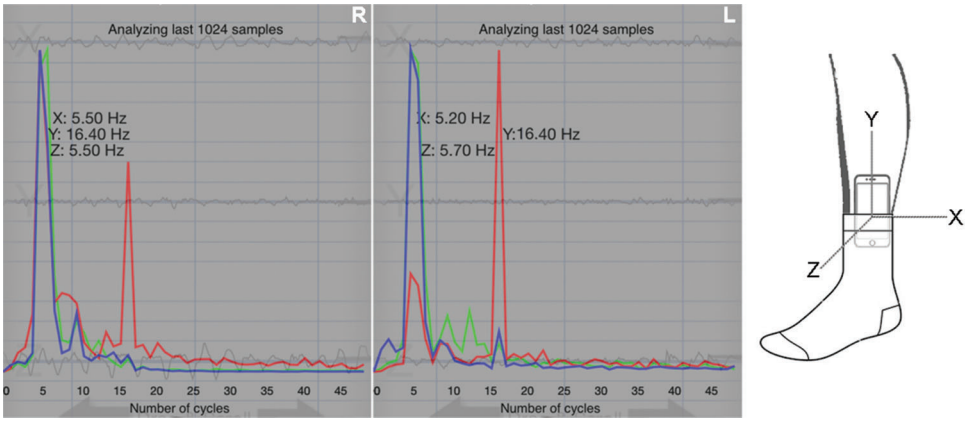

Figure 1. **Fast Fourier Transform of Orthostatic Tremor Accelerometer Recordings.** Tremor was recorded from the lower leg using a smartphone placed in the patient's sock. There is a 16.4 Hz *Y*-axis peak present in both legs, a feature characteristic of orthostatic tremor.

Nowadays, mobile devices with accelerometers are becoming increasingly utilized to measure tremor and can reliably assess acceleration when contrasted to EMG recordings.[3] Accelerometer-based smartphone applications have been utilized for tremors affecting the upper limbs, but their use in assessing lower limb tremors is yet to be established. Herein we present a case of OT on whom accurate recordings were conducted with a smartphone. We think this example sheds some light on the rapidly expanding adoption of smartphone-based applications in movement disorders.

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