Characterizing tongue tremor in Parkinson's disease using EMA

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Introduction

This abstract describes patterns of tongue tremor in two patients diagnosed with Parkinson's disease (PD). Resting tremor in PD is usually present at the upper and lower limbs, the lips and on the jaw. Tongue tremor is far less often reported and is argued to be rare in PD (Jaulent, Laurencin, Robert, & Thobois, 2015), but does occur often in patients with Essential Tremor (Lou & Jankovic, 1991). Previous work has described subjects for whom a tongue tremor was the first (Jaulent et al., 2015) or among the first signs of PD (Delil, Bölükbaşı, Yeni, & Kızıltan, 2015). In this study we describe two cases, both of which show a different pathology. In addition, we demonstrate that electromagnetic articulography (EMA) can be successfully used as a tool to identify intra-oral tremor, which is not possible when examining a patient's body only from the outside.

Method

24 patients diagnosed with idiopathic Parkinson's disease took part in this study. Before the experiment, they completed Part II of the International Parkinson and Movement Disorder Society UPDRS, including question 2.10 regarding tremor.

Subjects were asked to read out carrier phrases containing target words which were constructed for other purposes than the present study. EMA recordings were started two seconds prior to stimulus presentation and thus prior to the initiation of speech. Two sensors were placed on the dorsal midline of the tongue, one sensor was placed on each lip at the vermillion border and one sensor for tracking movement of the mandible (JAW) was placed either below the lower incisors (subject A) or on the chin (subject B). The posterior tongue sensor (TB) was located by using dental colour transfer applicators to stain the palate and determining the mark left on the tongue dorsum after the participant produced a /k/. The anterior tongue sensor (TT) was placed 1 cm. posterior to the tongue's apex.

In order to identify tremor on the resting tongue, the first two seconds of every recording were analyzed (i.e. where no speech was present). Vertical movement trajectories were smoothed using a robust discretized smoothing spline (Garcia, 2010), followed by an 8th order high-pass IIR filter with a cutoff frequency of 1 Hz to filter out the DC component. Log-transformed power density spectra were generated from 2048-pt FFTs calculated over rectangular 2s windows of the filtered signal intervals of interest. We then marked the peaks in the spectrum higher than 75% of the range and computed the RMS energy of the interval. Signals that both contained a marked spectral peak between 3-6 Hz and for which RMS was higher than 0.2 dB were classified as showing tremor.

Observations

We observed tongue tremor in 4 of the 24 PD patients (16.7%) included in our study. Below we discuss two patients, one who was showing an additional tremor on the jaw and one who reported to not be aware of any shaking or tremor.

Subject A was a 73-year-old male, who was diagnosed having PD 12 years ago. On question 2.10 of the UPDRS he reported a 1, stating that shaking or tremor occurred, but did not lead to any problems. Tongue tremor was identified on TB for 55 out of 80 trials; M frequency: 3.67, SD: 0.28; M RMS: 1.73, SD: 0.45) and on TT for 53 out of 80 trials (M frequency: 3.71, SD: 0.30; M RMS: 0.90, SD: 0.28). During 38 out of 80 trials an additional tremor was observed on the mandible with a more variable frequency than the tongue tremor (M frequency: 4.67, SD: 1.79; M RMS: 0.89, SD: 0.78).

Subject B was a 72-year-old male, who was diagnosed 3 years ago. On question 2.10 of the UPDRS he reported a 0, indicating that he experienced no shaking or tremor. Nevertheless, a tremor was observed on TB for 27 out of 81 trials (M frequency: 3.65, SD: 0.30; M RMS: 1.51, SD: 0.45) and on TT for 16 out of 81 trials (M frequency: 3.9, SD: 0.45; M RMS: 0.24, SD: 0.10). It emerged

when the tongue was raised and disappeared when it was lowered. In 16 trials a relatively weak tremor was observed on the jaw as well (M frequency: 4.66, SD: 0.87; M RMS: 0.23, SD: 0.03).

Upon visual inspection the frequencies *during speech* of the articulatory gestures were close to those of the tremor. Consequently, our method was not able to disentangle tremor from speech articulation and assess whether the tremor was present during speech. A future, more detailed analysis may be required to successfully do so.

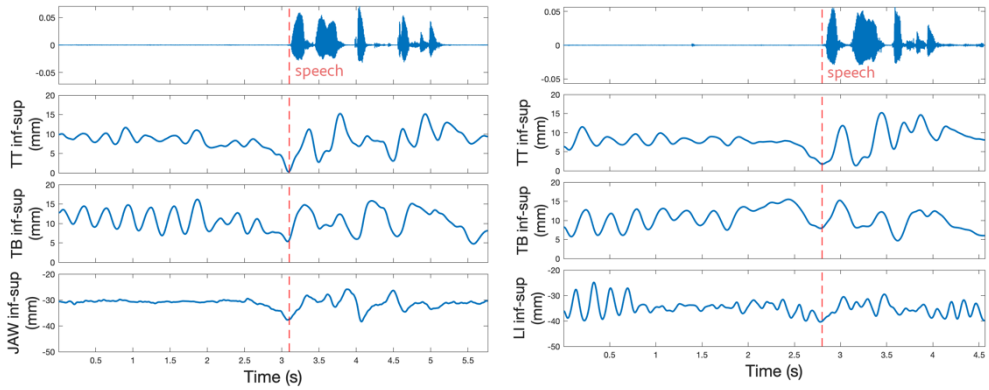

Figure 1. Tongue trajectories for subject A during two trials. Vertical trajectories of TT (2nd row), TB (3rd row) and JAW (bottom row) are shown over time. The waveform is shown in the top row. No clear tremor was observed for the JAW sensor in the left graph. In the right graph, however, a jaw tremor can be observed with higher frequency and amplitude than the tongue tremor.

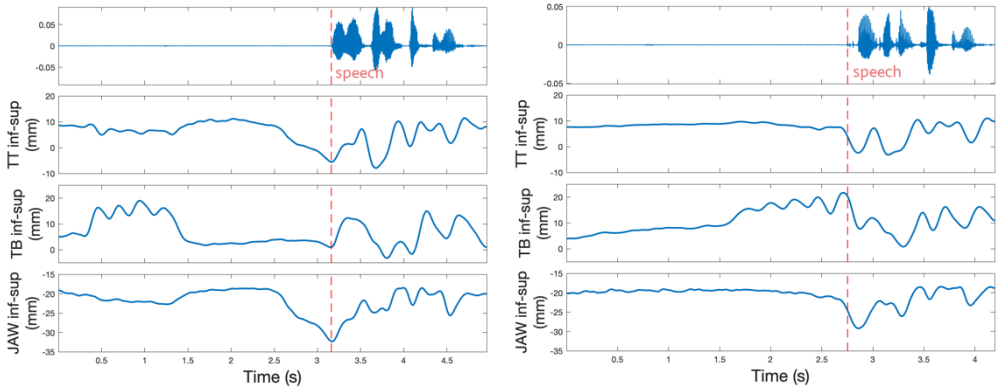

Figure 2. Tongue trajectories for subject B during two trials. Vertical trajectories of TT (2nd row), TB (3rd row) and JAW (bottom row) are shown over time. The waveform is shown in the top row. In the left graph, the tremor emerges with TB raising and dissolves as soon as it is lowered. In the right graph, the tremor also emerges with TB raising but does not dissolve before the initiation of speech.

Our results show clear examples of tongue tremor in 17% of our PD patients. As the tremor was most clearly detected at the posterior part of the tongue, the presence of tongue tremor may well be missed during a physical examination of the patient in the clinic. Particularly, since patients do not always seem to be aware of its existence. We argue that EMA (and potentially also ultrasound imaging) can successfully identify this tremor, as it does not put any strain on the muscles, in contrast to the general physical examination where a patient would at least have to lower the jaw for the tongue to be examined. Since previous studies have found tongue tremor to be amongst the first signs of PD, we believe that an examination of the tongue in an early stage may be valuable in the diagnostic process.

References

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