Name: [redacted]
DOB: [redacted]
MRN: [redacted]
ID#: 2023-001
Date of study: [redacted]

History of present illness:
60 year old Left-Handed female with left hand tremor since 20 years old. Gradually, tremors progressed, and in her 50s, she also noticed tremor in her right hand. Around that time, she had bilateral VIM DBS (right VIM October 2013 and left VIM April 2014) which provided some benefit for about 5 years. In 2018, a third lead was placed in the GPI which was explanted within a few days due to infection (not enough time to evaluate for benefit). In 2019 she had bilateral VIM DBS reimplantation (Medtronic leads explantation and implantation of Abbott, directional leads, [redacted] She has been receiving some tremor benefit from the DBS but the tremor continues to be bothersome.

Reason of study:
To investigate functional vs essential tremor.

Technique:

Actigraphy was performed with tri-axial accelerometers. Surface electromyography (EMG) was used in a belly tendon montage. Set-up as below:

☐ one triaxial accelerometer in the dorsum of RIGHT hand
☒ Surface EMG on RIGHT wrist extensor muscles
☒ Surface EMG on RIGHT wrist flexor muscles
☒ one triaxial accelerometer in the dorsum of LEFT hand
☒ Surface EMG on LEFT wrist extensor muscles
☒ Surface EMG on LEFT wrist flexor muscles

The patient was requested to perform several motor tasks.

☒ Rest (forearms supported on the armrest, hand hanging freely)
☒ Posture (arms outstretched at shoulder level, elbows extended, wrists slightly extended, fingers spread)
☒ Kinetic (forearms supported on the armrest, wrists in flexion-extension alternating motion)
☒ Weight loading with 1Lb at the dorsum of the hand
☒ Weight loading with 1.5Lbs at the dorsum of the hand
☒ Weight loading with 2Lbs at the dorsum of the hand

☒Ballistic arm movements
☒Tapping 1Hz
☒Tapping 3Hz
☒Tapping 5Hz

Recordings for 30-60seconds per task were performed. The data was stored in a computer for off-line analysis.

☒Custom-made MatLab codes were used for analysis.
☒An online tremor analysis tool was used for analysis (Vial F et al. Clin Neurophysiol Pract. 2019, PMID: 31956739)

Analysis:

The accelerometry signal was amplified and band-pass filtered between 2 and 20Hz. The EMG signal was amplified, band-pass filtered between 2-350Hz and rectified. The EMG and accelerometry signals were converted to the frequency domain with a Fast Fourier Transform. Coherence analysis was performed between two signals, with 0 indicating complete lack of coherence and 1 indicating perfect coherence of the two analyzed signals.

The 2016 criteria for functional tremor were used: Schwingenschuh P et al. Validation of "laboratory-supported" criteria for functional (psychogenic) tremor. Mov Disord. 2016 Apr;31(4):555-62. PMID: 26879346.

Results:

Total power (1-30Hz) during posture with and without loading (points: 0)

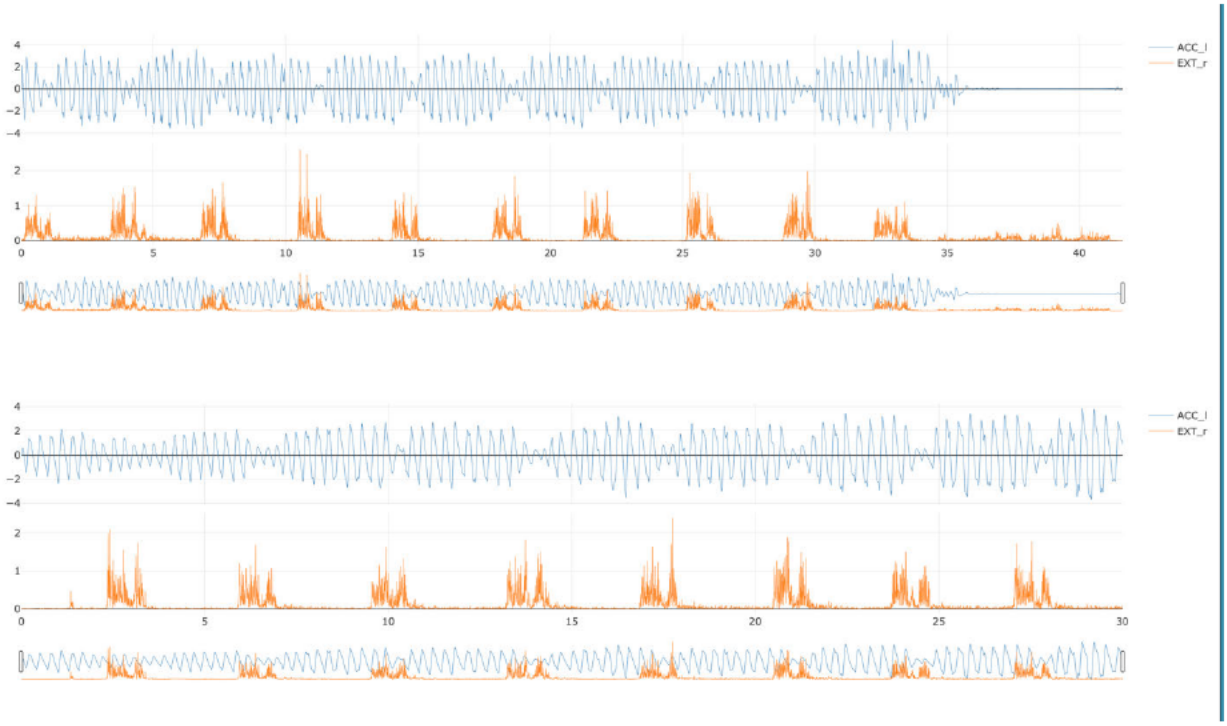
Tremor amplitude was expressed as the total power between 1 and 30 Hz. The TP in the left accelerometer was modified between no-weight and weight-loading conditions as below:

Posture with no weight: TP=0.23596
Posture with 1Lb weight loading: TP=0.27236
Posture with 1.5Lb weight loading: TP=0.28653
Posture with 2Lb weight loading: TP=0.22418

Weight loading did NOT result in TP increase of more than 130%

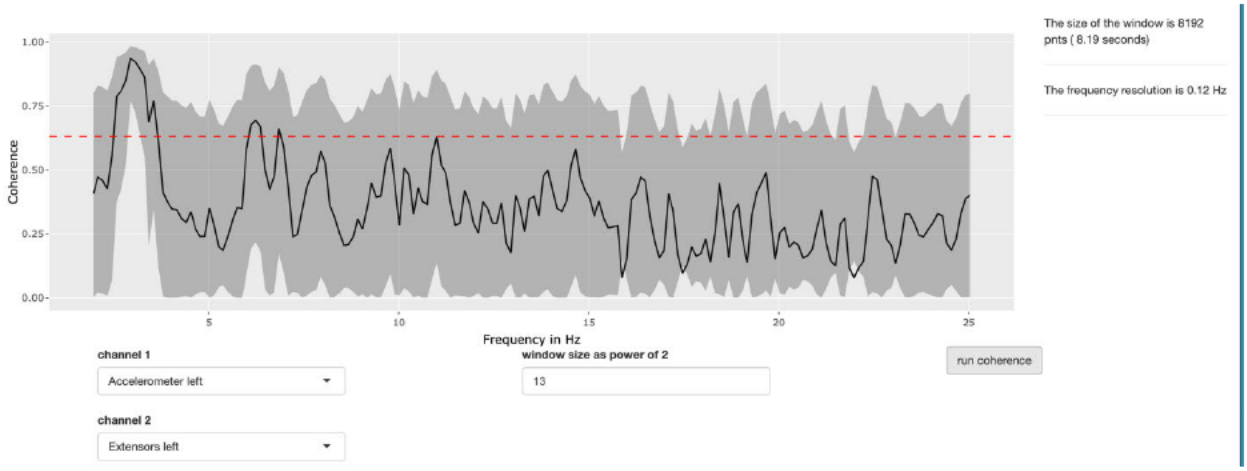
Ballistic movements (points: 1)

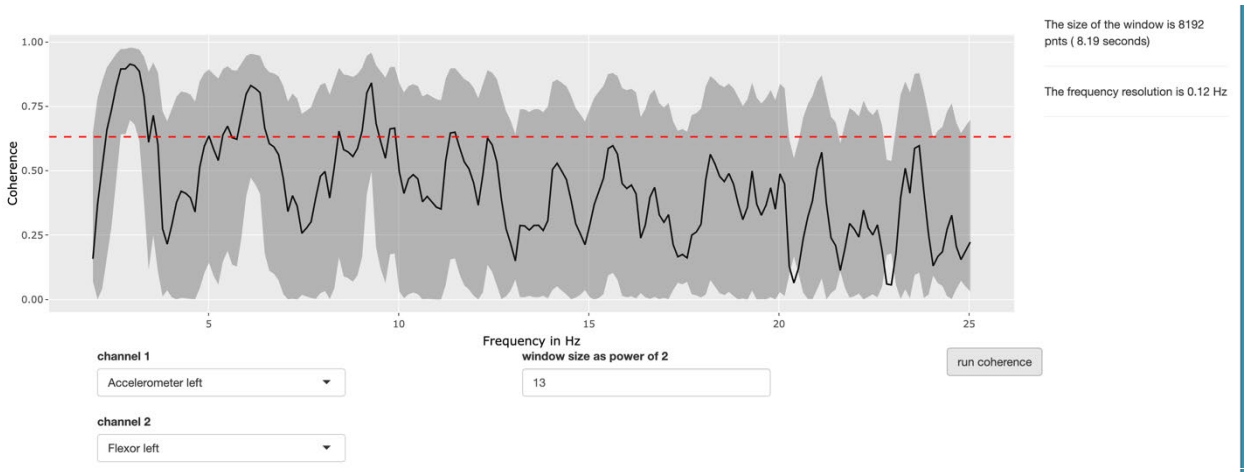
The tremor amplitude decreased by at least 50% with contralateral ballistic movement

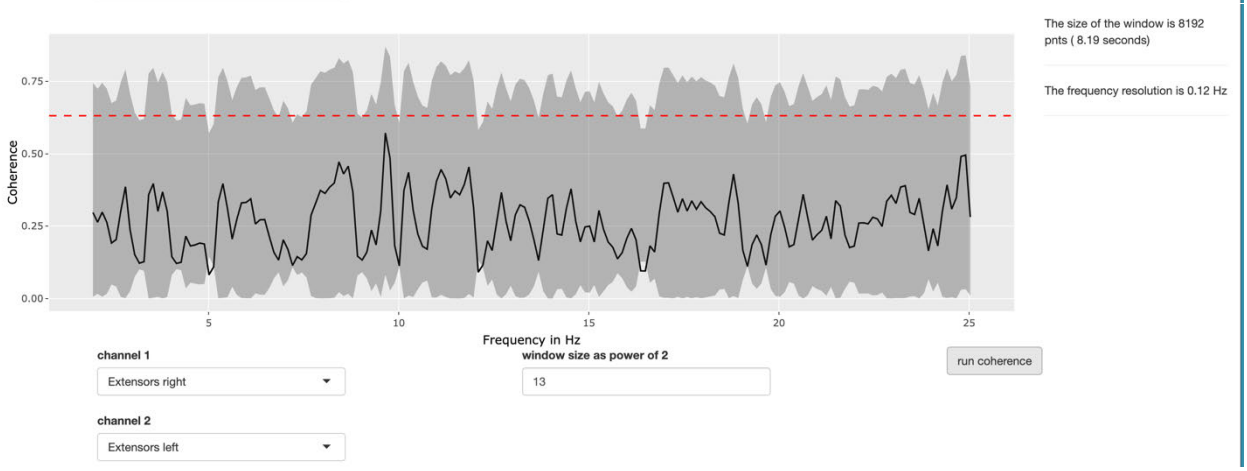


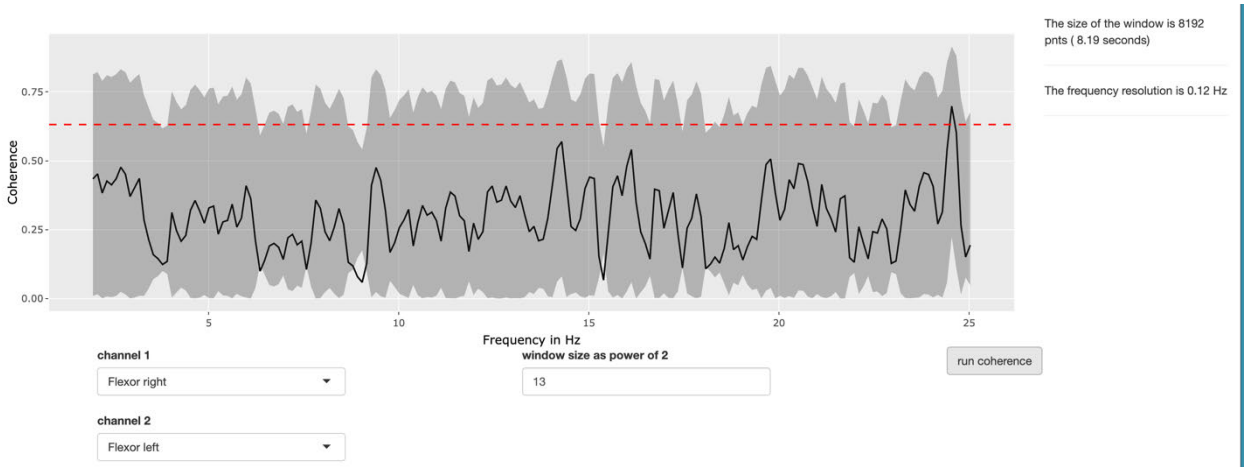
Coherence test (points: 0)

During posture with arms outstretched, there was no significant EMG coherence between left and right flexors or extensor muscles. There was significant coherence of the left Accelerometer with Left extensors and left flexors.



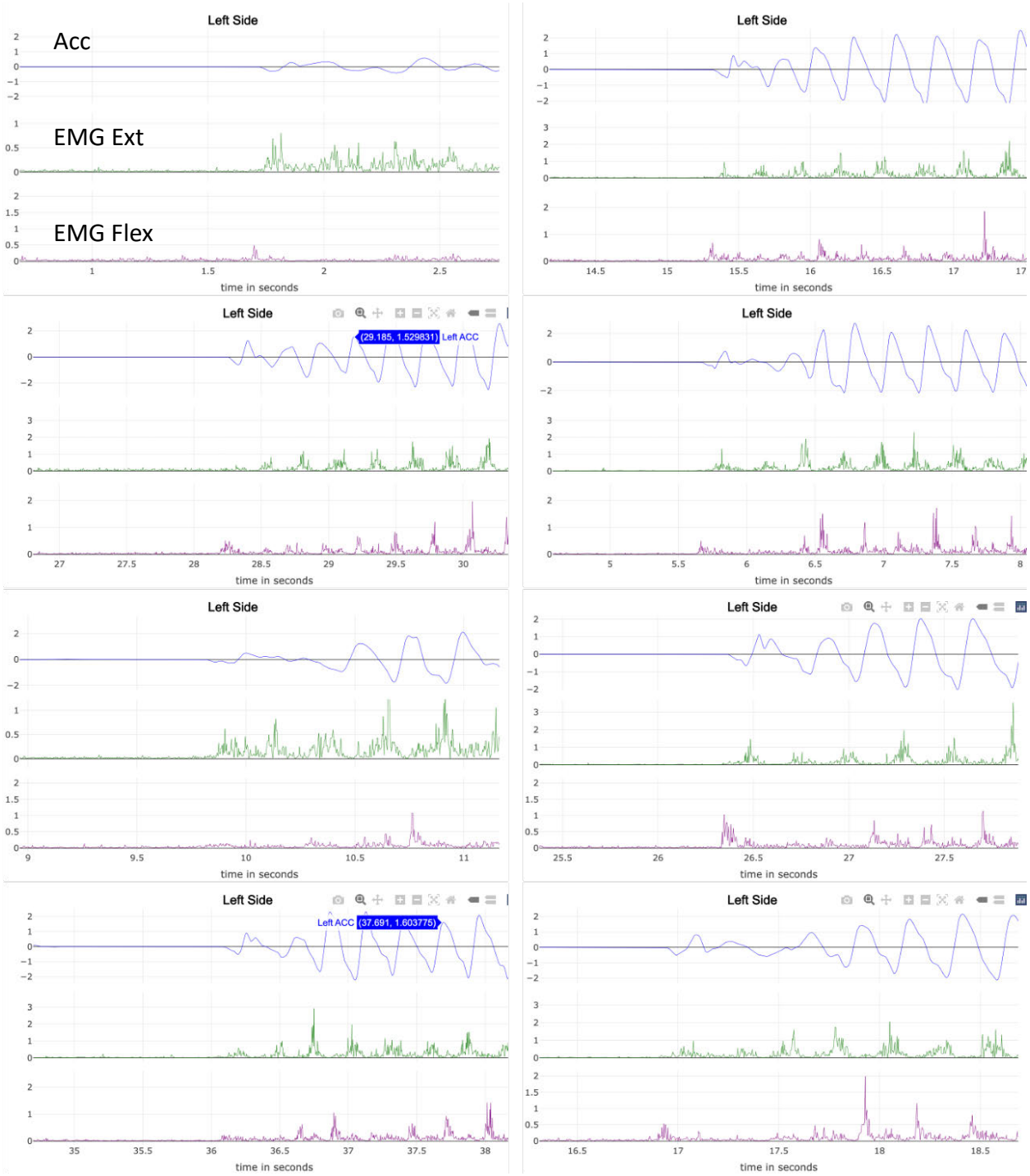






Tonic coactivation (points: 0)

There was no clear tonic coactivation of antagonist muscles 300ms before the onset of tremor bursts.

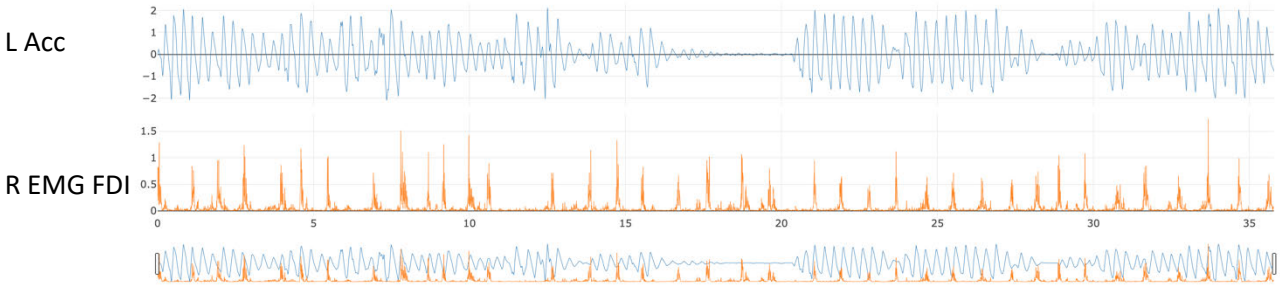


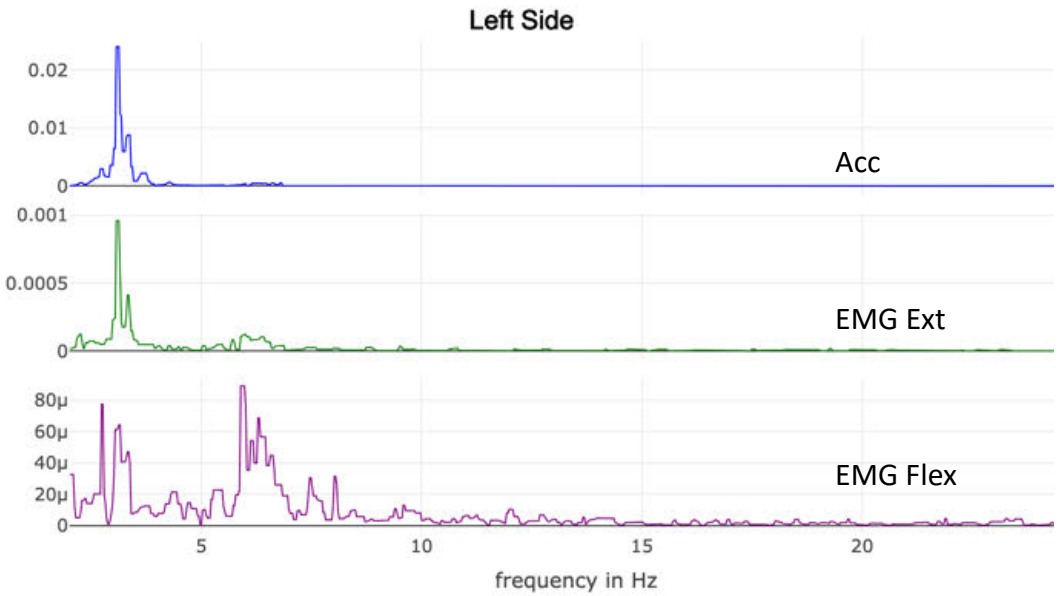
FINGER TAPPING TASKS

Correct tapping performance for 1, 3, and 5 Hz was predefined as 0.5–1.5Hz, 2.5–3.5Hz, and 4.5–5.5Hz, respectively (per Schwingenschuh et al). Tremor response was assessed for entrainment, tremor suppression, or pathological frequency shift defined as a frequency shift of at least 19.0%, 26.9%, and 25.7% during contralateral tapping at 1, 3, and 5Hz, respectively (per Schwingenschuh et al).

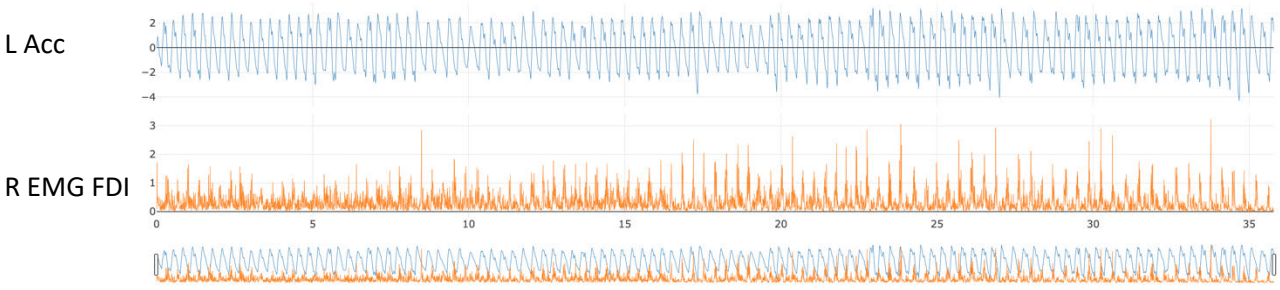
Finger tapping was performed on the right hand, and tremor response was evaluated on the left hand.

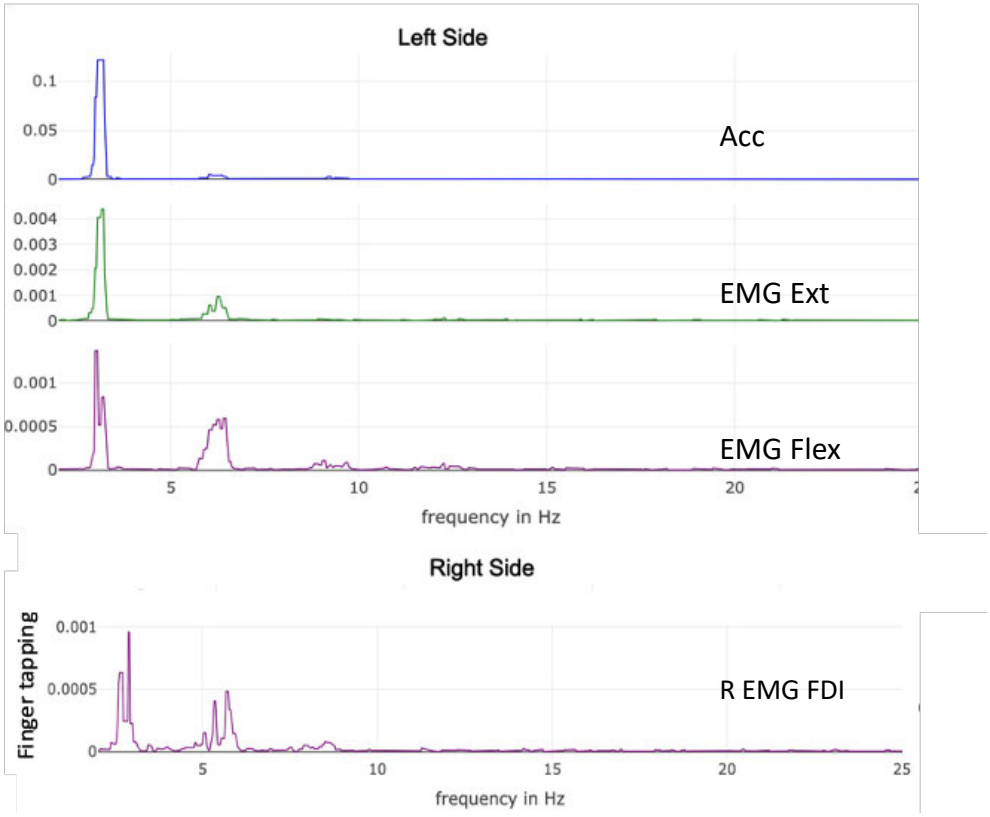
Tapping 1Hz (performance points: 0, response points:1)
Right-hand finger tapping frequency was 1.08Hz. The left-hand tremor frequency did not change, but the amplitude fluctuated during the recordings and almost stopped for a few seconds.





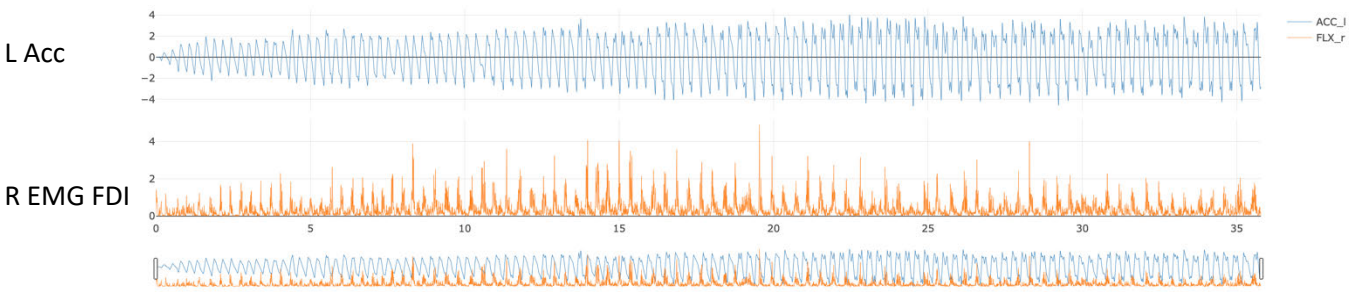
Tapping 3 Hz (performance points: 0, response points:0)
Right-hand finger tapping frequency was 2.9Hz. The left-hand tremor frequency was 3.1Hz.

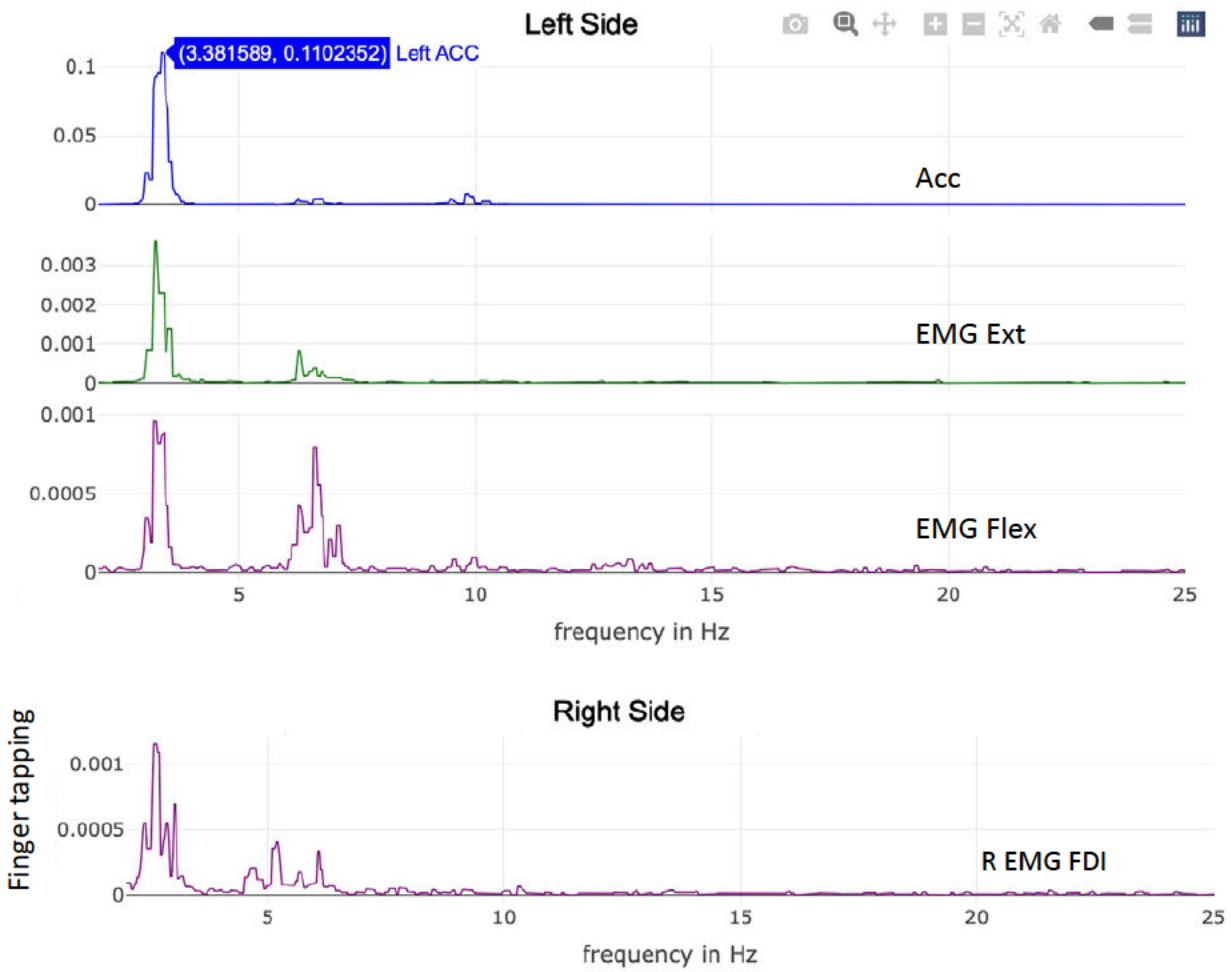




Tapping 5Hz (performance points: 1, response points:0)

Right-hand finger tapping frequency was 2.6Hz. The left-hand tremor frequency was 3.38Hz.





Summary:

Test	Points
Loading	0
Response to ballistic movement	1
Coherence test	0
Tonic coactivation	0
Tapping performance 1Hz	0
Tapping performance 3Hz	0
Tapping performance 5Hz	1
Tapping response 1Hz	1
Tapping response 3Hz	0
Tapping response 5Hz	0
Total	3

Impression:

In summary, the patient collected 3 points, which is above the cut-off for the diagnosis of laboratory-supported functional tremor. Therefore, this study is suggestive of presence of functional tremor. Per Schwingenschuh et al. 2015 criteria, the predefined cut-off score for a diagnosis of laboratory-supported functional tremor with 3 of 10 points yielded a test sensitivity of 89.5% and a specificity of 95.9%.