Identifying Electroencephalography Biomarkers of Post COVID-19 Condition Symptoms

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INTRODUCTION

- 10 to 20% of people infected with SARS-CoV-2 develop symptoms that extend beyond 12 weeks post-infection, which is defined as post COVID-19 condition (**PC19**)[1].
- Six months post-infection, the three most common symptoms are fatigue, brain fog, and post-exertional malaise (PEM)[2].
- The brain is among the organs affected by COVID-19, where grey matter loss[3] and decreased motor cortex excitability[4] have been reported.
- The neural correlates associated with PC19 symptoms are still not properly understood.

Using electroencephalography (EEG), we will study PC19 brain features in terms of:

1. Motor-Related Beta Desynchronization (**MRBDs**), as they have been linked to fatigue and aging (**Fig. 1**)[5].

2. Functional Connectivity (**FC**) and Graph Theory Analysis (**GTA**) to study neural communication and states of consciousness[6].

Figure 1. Temporal evolution of MRBD in the motor cortex during a handgrip task (Xifra-Porxas *et al.,* 2019).

AIMS & HYPOTHESES

- The objective is to quantify abnormal brain oscillatory patterns present in PC19 individuals and their association with the three main lingering symptoms, namely fatigue, PEM and brain fog.

- We expect to find features typical of aging, such as larger MRBD[5] amplitude, that will be positively correlated to fatigue. We also expect increased symptoms to be associated with alterations in FC and GTA features.

STUDY DESIGN & METHODS

Figure 2. Description of the timeline of the study and the tools that will be used for the measures.

- This is a cross-sectional study with matched-pairs design & an exploratory repeated meassures component. We will compare a PC19 group (n=15) to controls matched in age and sex (n=15) (IRB#22-10-078).
- During the first session, participants complete the FSS, the CFQ, and the DSQ-PEM to evaluate fatigue, brain fog, and PEM (**Fig. 2**).
- The Creyos platform is used to assess specific cognitive domains.
- Brain activity is recorded using EEG (BrainVision) during periods of rest and movement. Following a cognitive efforts, these measures will be repeated.
- Differences between groups in terms of EEG features including MRBDs, FC, GTA metrics, and criticality will be estimated as well as their association with symptoms of fatigue, PEM and brain fog.

PRELIMINARY RESULTS

Data collected from 16 PC19 individuals and 3 matched controls.

Test	PC19 n=16 Mean (SD)	Control n=3 Mean (SD)
Age	43.5 (9.9)	39 (4.3)
Hospitalizations	0	N/A
Time since infection	26 months	N/A
FSS	56.5 (5.8)	29.6 (24.6)
CFQ	61.6 (16.0)	18.6 (8.6)
DSQ-PEM	100%*	0%*

Figure 3. Mean scores are represented with the standard deviation (SD). FSS > 36 may indicate severe fatigue. CFQ ≥43 is defined as a high score. DSQ-PEM percentages represent the participants who met the criteria for PEM.

Scores from the PC19 group in the Creyos tasks

Creyos		
Cognitive dommain	**Task**	**Score (n)**
Concentration	Double trouble	68% (14)
Concentration	Feature Match	81% (15)
Short Term Memory	Monkey Ladder	72% (15)
Short Term Memory	Paired Associates	71% (14)
Reasoning	Rotations	66% (14)
Reasoning	Odd one out	68% (15)
Verbal	Grammatical Reasoning	76% (15)
Verbal	Digit span	60% (14)

Figure 4. Average scores of the PC19 group are represented in percentiles. The normal distribution is a score of 100%. (n) represent the number of participants whose scores were valid and taken into account for the averages

DISCUSSION

- Preliminary results show that individuals from the PC19 group have scores indicating severe fatigue (FSS), high cognitive failures (CFQ) and present symptoms of PEM (DSQ-PEM).

- The percentiles observed in the Creyos tasks show that some domains, such as reasoning and verbal habilities are more impaired than other in this population.

- EEG patterns will be extracted and analyzed in relation to the observed clinical outcomes.

SIGNIFICANCE

- There are currently no straightforward ways to diagnose, prevent or treat PC19.

- An estimated 1% of individuals in Canada are still unable to return to their pre-COVID-19 level of functioning due to the debilitating symptoms of this condition[7].

- This study represents a critical step for identifying biomarkers of PC19, which could ultimately contribute to developing effective diagnostic techniques and targeted treatments to improve the debilitating symptoms experienced by this population.

ACKNOWLEDGEMENTS

REFERENCES

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