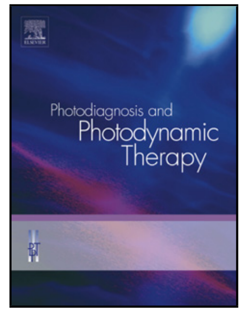
Journal Pre-proof



Optical techniques for fast screening – towards prevention of the coronavirus COVID-19 outbreak

Luis Felipe das Chagas e Silva de Carvalho, Marcelo Saito Nogueira

PII: S1572-1000(20)30118-6

DOI: https://doi.org/10.1016/j.pdpdt.2020.101765

Reference: PDPDT 101765

To appear in: *Photodiagnosis and Photodynamic Therapy*

Received Date: 29 March 2020

Photodiagnosis and Photodynamic Therapy __ (2020) ____

Contents lists available at ScienceDirect

Photodiagnosis and Photodynamic Therapy

journal homepage: www.elsevier.com/locate/pdpdt

Letter to the Editor

Optical techniques for fast screening – towards prevention of the coronavirus COVID-19 outbreak

Luis Felipe das Chagas e Silva de Carvalho, Marcelo Saito Nogueira*

**Corresponding author*

Tyndall National Institute/University College Cork - Lee Maltings Complex, Dyke Parade, Cork, Ireland, Postcode: T12R5CP;

Universidade de Taubaté. R. dos Operários, 09 - Centro, Taubaté - SP, 12020-340; luisfelipecarvalho@hotmail.com

Centro Universitário Braz Cubas. Av. Francisco Rodrigues Filho, 1233 - Vila Mogilar, Mogi das Cruzes - SP, 08773-380;

E-mail address:

luisfelipecarvalho@hotmail.com (L. F. C. S. Carvalho)

marcelosaitonogueira@gmail.com (M. S. Nogueira)

Highlights

- Coronavirus disease 2019 (COVID-19) is emerging and requires early diagnostics.
- Biomarkers are present for coronaviruses.
- Raman and FT-IR spectroscopy are green technologies capable of high-throughput virus sensing.

The increasing need of high-throughput virus sensing is emerging due to the Coronavirus disease 2019 (COVID-19) outbreak. This letter focuses on increasing the awareness academic institutions about the possibility of incorporating vibrational spectroscopy techniques (Raman and Fourier-transform infrared (FT-IR) spectroscopy) for healthcare, especially motivating researchers to address COVID-19 related topics. We believe that those techniques are sensitive to the virus and can assist in the early and fast diagnosis to contain the new pandemic.

COVID-19 is the latest biological hazard to pose threat to healthcare, political, economic and social sectors worldwide. Countries which are part of the developed or under development world could have benefitted from technologies able to perform high throughput COVID-19 sensing to prevent the virus outbreak [1,2].

The infection is associated to strains of SARS-CoV-2 virus. Since the SARS-CoV-2 can be transmitted by direct routes including cough, sneeze, and droplet inhalation and contact routes such as contact with nasal, oral, and eye mucous membranes, the virus has been proven to be present on human biofluids [3]. Biofluids include saliva, blood, and possibly sputum, tears, and wound secretion, which contain specific disease biomarkers such as proteins, nucleic acids, lipids, carbohydrates, hormones, phosphate, carotenoids. Biomarkers are present in coronaviruses, as their constitution comprises a single strand of positive-sense RNA involved by structural proteins/glycoprotein and lipids of their nucleocapsid, matrix and envelope. In addition, the S protein from coronavirus can bind to the host cell-membrane receptors to facilitate viral entry into cells including the human angiotensin converting enzyme 2 (ACE2) receptor [2]. These biomarkers can be targeted by molecular specific diagnostic tests such as vibrational spectroscopy.

Raman and FT-IR are emerging methods that allow real-time, non-invasive and non-destructive analysis of biofluids and biological tissues [4,5]. In terms of FT-IR spectroscopy, attenuated total reflectance (ATR) crystals allow biofluids analyzes performed in seconds. Raman spectroscopy is highly specific and can be used to analyze biofluids samples directly or to analyze the virus binding on ACE2 receptors of the host cells. In this case, exfoliative cytology or cell cultures may allow another potential diagnostic option for cell analysis. State-of-the-art of vibrational spectroscopy are sufficiently flexible to incorporate label-free analysis of small sample sizes, which makes vibrational spectroscopy a green technology capable of high-throughput virus sensing.

We believe the most effective way of using FT-IR and Raman spectroscopy to perform virus sensing is separating mass-screening and biomolecular characterization applications. Due to the portability and low-noise measurements provided by FT-IR ATR spectroscopy, it can be widely used for cost-effective mass screening at hospitals, clinics, airports, among other places. The strong molecular specificity and water-free signals of Raman spectroscopy allows the technique to be used for biochemical profiling of cells in biofluids and cell cultures. The analysis of cell biochemistry can be relatively fast in order to provide the intracellular changes correlated to the disease, especially molecular-specific associations between the host cell and the virus. These changes can be further related to the pathophysiology of the patients in the clinic and investigation of new treatment/containment modalities.

The implementation of spectroscopic techniques is facilitated by the small sample size required, the real-time evaluation and the possibility of designing user-friendly software. By applying multivariate analysis to the mass screening data, systems showing colors for healthy, dubious and diseased cases could further fasten the screening and increase adherence rates.

Once vibrational spectroscopy is applied in a large scale, the costs can be reduced and extended to low-resource settings, as the minimal sample preparation can keep operational costs low. Additional benefits of large-scale application of vibrational spectroscopy are the creation of an environment that supports the diagnosis of associated diseases.

In general, we would like to reinforce the potential of COVID-19 studies using the techniques described in this letter. We are going through a dark moment when the diagnosis and treatment strategies for the disease are still premature. With this in mind, new modalities must be evaluated for the direct benefit of patients in order to accelerate the diagnostic process and contribute to the cure of COVID-19.

Funding sources

Luis Felipe CS Carvalho is funded by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) -PNPD Odontologia/UNITAU, and Centro Universitário Braz Cubas – Research Program

Conflicts of interest

The authors declare no conflicts of interest.

References

[1] World Health Organization. (2020). Coronavirus disease 2019 (COVID-19): situation report, 51.
[2] Loeffelholz, M. J., & Tang, Y. W. (2020). Laboratory Diagnosis of Emerging Human Coronavirus Infections—The State of the Art. Emerging Microbes & Infections, (just-accepted), 1-26
[3] Peng, X., Xu, X., Li, Y., Cheng, L., Zhou, X., & Ren, B. (2020). Transmission routes of 2019-nCoV and controls in dental practice. International Journal of Oral Science, 12(1), 1-6.
[4] Leal, L. B., Nogueira, M. S., Canevari, R. A., & Carvalho, L. F. C. S. (2018). Vibration spectroscopy and body biofluids: Literature review for clinical applications. Photodiagnosis and photodynamic therapy, 24, 237-244

[5] Carvalho, L. F. D. C. S, & Nogueira, M. S. (2018). New insights of Raman spectroscopy for oral clinical applications. Analyst, 143(24), 6037-6048.

Luis Felipe das Chagas e Silva de Carvalho, Marcelo Saito Nogueira

Tyndall National Institute/University College Cork - Lee Maltings Complex, Dyke Parade, Cork, Ireland, Postcode: T12R5CP;
Universidade de Taubaté. R. dos Operários, 09 - Centro, Taubaté - SP, 12020-340; luisfelipecarvalho@hotmail.com
Centro Universitário Braz Cubas. Av. Francisco Rodrigues Filho, 1233 - Vila Mogilar, Mogi das Cruzes - SP, 08773-380;

E-mail address:
luisfelipecarvalho@hotmail.com (L. F. C.e S. Carvalho)
marcelosaitonogueira@gmail.com (M. S. Nogueira