International Journal of Biomedicine 12(4) (2022) 622-626
http://dx.doi.org/10.21103/Article12(4)_OA18

ORIGINAL ARTICLE

COVID-19

INTERNATIONAL JOURNAL OF BIOMEDICINE

Diffractive Phase Interferometry (DPI), CRP and COVID-19 RT-PCR Tests in COVID-19 Patients with Different Ages in AJMAN, UAE: A Comparative Study

Salah Eldin Omar Hussein*, Abd Elgadir Alamin Altoum, Ahmed L. Osman, Ayman Hussien Alfeel, Sara Ali, Marwan Ismail, Hassan M. K. I. Higazi

Department of Medical Laboratory Sciences, College of Health Sciences, Gulf Medical University, Ajman, United Arab Emirates

Abstract

***Background*:** Fast and accurate diagnosis plays an important role in controlling and further preventing COVID-19. This study was conducted in the Thumbay laboratory of Gulf Medical University (Ajman, UAE) to assess the correlations between DPI (Diffractive Phase Interferometry), COVID-19 RT-PCR, and CRP tests in COVID-19 patients of different ages and to compare the effectiveness of each parameter.

Methods and Results: A cross-sectional analytic study was conducted among 150 patients diagnosed with COVID-19 who were admitted to the Thumbay University Hospital. Their general data was collected from the LDM system, and from among the suspected patients who came to do the RT-PCR test, 230 were selected as volunteers to participate in this study, and further laboratory tests like CRP level and DPI test were done for them. The nasal swab was collected for a PCR test.

Out of 230 nasal swab samples, 150 were positive and 80 were negative for SARS-CoV-2 RNA by real-time RT-PCR assay. Among the 150 positive RT-PCR, 90 false negative DPI tests were from a sample with a high real-time RT-PCR. While 60 true positive DPI tests were positive real-time RT-PCR for swab specimens. Among the 80 negative RT-PCR, 79 were true negative and 1 was a false positive. The predictive positive value of the DPI test was 40% and the predictive negative value of the test was 98%. DPI has at least one tie between the positive actual state group and the negative actual state group. The results show weak and moderate positive correlations between CRP and the age groups.

Conclusion: The combined detection of the three indicators (RT-PCR, DPI, and CRP) are positively related to COVID-19 infection; therefore, these indicators will enable effective intervention measures to be implemented in time and the rates of severe illness and mortality to be reduced.(**International Journal of Biomedicine. 2022;12(4):622-626.**).

Keywords: Diffractive Phase Interferometry • COVID 19 • C-reactive protein • polymerase chain reaction

For citation: Hussein SEO, Altoum AEA, Osman AL, Alfeel AH, Ali S, Ismail M, Higazi HMKI. Diffractive Phase Interferometry (DPI), CRP and COVID-19 RT-PCR Tests in COVID-19 Patients with Different Ages in AJMAN, UAE: A Comparative Study. International Journal of Biomedicine. 2022;12(4):622-626. doi:10.21103/Article12(4)_OA18

Abbreviations

DPI, Diffractive Phase Interferometry; **CRP**, C-reactive protein; **RT-PCR,** reverse transcription polymerase chain reaction.

Introduction

Fast and accurate diagnosis plays an important role in controlling and further preventing COVID-19.[1] During the pandemic, scientists developed rapid tests to diagnose viral infection.[2] One of the techniques that has been implemented for the diagnosis of COVID-19 is laser-based DPI technology (Diffractive Phase Interferometry), which was developed in the UAE by QuantLase Imaging Lab to detect COVID-19 cases.[3] This is the first step in examining the suspected COVID-19 cases. DPI technique uses a laser-based technology based on optical-phase modulation, deriving a blood sample to screen the virus

within a few seconds on a large–scale population. Moreover, it is user-friendly, non-invasive, and also cost-effective.[4] This test is not used only in hospitals, but it can also be accepted in some places, in public places like cinemas, shopping malls, and travelers between different emirates of UAE. Furthermore, with a 'little hands-on training,' it can be used for testing and monitoring COVID-19 cases.[5] On the other hand, detection of SARS-CoV-2 RNA through a real-time RT-PCR assay is used to confirm the clinical diagnosis of COVID-19 by diagnostic laboratories.[6] The screening for COVID-19 is via a nasal swab; the genetic material of SARS-CoV-2 or RNA within the swab will be detected and isolated. Essentially, this technique combines reverse transcription of the RNA genetic material from the nasal swab into DNA and then amplifies these DNA targets via PCR, which helps measure the quantity of a specific virus RNA in the sample.[7]

Materials and Methods

A cross-sectional analytic study was conducted among 150 patients diagnosed with COVID-19 who were admitted to the Thumbay University Hospital. Their general data was collected from the LDM system, and from among the suspected patients who came to do the RT-PCR test, 230 were selected as volunteers to participate in this study, and further laboratory tests like CRP level and DPI test were done for them.

The nasal swab was collected for a PCR test. The patient must be seated in a comfortable position with the head tilted back slightly to make the nasal passages more accessible. A flexible plastic stick with a synthetic fiber swab is gently inserted into one of the nostrils (in some cases, samples are collected from both nostrils). The swab must go quite far back along the passage that connects the base of the nose to the back of the throat. The swab is kept in for 10-15 seconds while being rotated around to collect the sample accurately and adequately. Finally, the swab is removed slowly and gently and immediately placed in a special container to be sent for analysis in the laboratory. The whole process takes approximately 30-40 seconds.

For the CPR test, the specimen used is plasma, and the preferred collection container is an EDTA tube when the collection specimen requires 2mL of plasma. An Immunoturbidi-metric test for CRP provided by Abbott Diagnostics (Abbott Park) was evaluated. The assay is performed by testing a suspension of latex particles coated with anti-human CRP antibodies against unknown serum. The presence of a visible agglutination indicates an increase of the CRP level above the upper limit of the reference interval in the samples tested. The minimum detectable unit (analytical sensitivity) is approximately 6 mg/L (5-10 mg/L).[8]

The RT-PCR test is considered a standard for diagnosing COVID-19. The screening is conducted by assessing a nasal swab; this method is a real-time assessment to detect SARS-CoV-2 genetic material or RNA from a person's upper and lower respiratory specimens.

Laser-based DPI technology is used to examine blood samples to detect the virus. DPI technique, based on optical-phase modulation, is used to scan a blood sample for signs of surging red blood cells. DPI technology allows the health authorities to carry out large-scale screening within a few seconds to detect suspected cases of infections before they undergo a PCR swab test. All instruments should be validated by checking the precision, linearity, and accuracy according to the lab quality control protocol.

Statistical analysis was performed using statistical software package SPSS version 24.0 (SPSS Inc, Armonk, NY: IBM Corp). All values are presented (reported) as mean ± standard deviation (SD) or as number and percentage. For data with normal distribution, inter-group comparisons were performed using Student's t-test. Multiple comparisons were performed with one-way ANOVA. Correlation coefficients were calculated by linear regression analysis. A probability value of $P<0.05$ was considered statistically significant.

Written informed consent was obtained from all subjects involved in the study. Ethical approvals were obtained from the research center at College of Health Sciences, Gulf Medical University (Ajman, United Arab Emirates) before collecting data. The data was only used for study purposes without individual details identifying the patient.

Results

The study was conducted in the Thumbay laboratory of Gulf Medical University (Ajman, UAE) on 150 participants of different ages (Table 1).

Table 1.
Demographics of patients with COVID-19

Demographic parameters	Variable	Age range (years)	Patients	
			Number	%
Age group	Child group	0 – 16	4	2.7%
	Young adults	17 - 30	21	14%
	Middle-aged adults	31 - 45	89	59.3%
	Old-aged adults	Above 45	36	24%
Gender	Male	15 - 63	59	39.3%
	Female	13 - 62	91	60.7%

The results obtained showed significant differences in CRP levels in COVID-19 patients of different ages, gender, and data of PCR and DPI (Table 2).

The observed weak and moderate positive correlations between CRP and the age groups are presented in Figures 1-4.

Out of 230 nasal swab samples, 150 were positive and 80 were negative for SARS-CoV-2 RNA by real-time RT-PCR assay. Among the 150 positive RT-PCR, 90 false negative DPI tests were from a sample with a high real-time RT-PCR. While 60 true positive DPI tests were positive real-time RT-PCR for swab specimens. Among the 80 negative RT-PCR, 79 were true negative and 1 was a false positive. The predictive positive value of the DPI test was 40% and

the predictive negative value of the test was 98.8%. DPI has at least one tie between the positive actual state group and the negative actual state group. The sensitivity of the test was 98.4%, and the specificity of the test was 46.7%. The smallest cut-off value is the minimum observed test value minus 1, and the largest cut-off value is the maximum observed test value plus 1. All the other cut-off values are the averages of two consecutive ordered observed test values (Tables 3-4 and Figure 5).

Table 2.

CRP levels in COVID-19 patients of different ages, gender, and data of PCR and DPI

Parameters		CRP	P-value
Age / Years	Child	(13.1 ± 2.8)	0.0000
	Young Adults	(26.7 ± 4.3)	
	Middle-aged adults	(39.2 ± 5.9)	
	Old-aged adults	(57.4 ± 7.2)	
Gender	Male	(27.4 ± 4.1)	0.0018
	Female	(25.5 ± 3.2)	
PCR	Positive	(51.3 ± 6.3)	0.1460
	Negative	(50.1 ± 5.2)	
DPI	Swab	(33.6 ± 5.1)	0.7872
	No swab	(33.4 ± 4.9)	

Table 3.

Mathematical calculation of Sensitivity and Specificity

Sensitivity of the test:

$$\frac{True\ positive}{True\ positive\ +\ False\ negative} \times 100$$

$$\frac{60}{60+1} \times 100 = 98.4\%$$

Specificity of the test:

$$\frac{True\ negative}{True\ negative\ +\ False\ positive} \times 100$$

$$\frac{79}{79+90} \times 100 = 46.7\%$$

Predictive positive value of the test:

$$\frac{True\ positive}{True\ positive\ +\ False\ positive} \times 100$$

$$\frac{60}{60+90} \times 100 = 40\%$$

Predictive negative value of the test:

$$\frac{True\ negative}{True\ negative\ +\ False\ negative} \times 100$$

$$\frac{79}{79+1} \times 100 = 98.8\%$$

Table 4.

Sensitivity and specificity of PCR*DPI

Variable			DPI		Total
			SWAB	NO SWAB	
PCR	POSITIVE	Count	60	90	150
		% Within DPI	40%	60%	65%
	NEGATIVE	Count	1	79	80
		% Within DPI	1.25%	98.75%	35%
Total		Count	61	169	230
		% Within DPI	26.5%	73.5%	100.0%

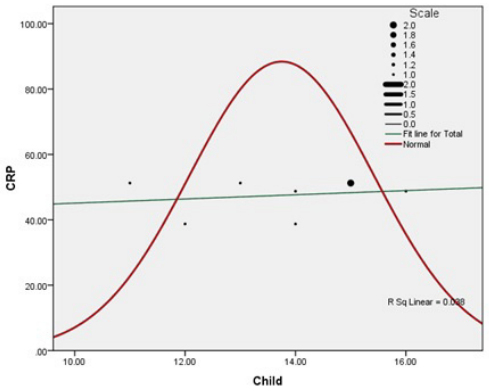

Fig. 1. *A weak positive correlation between child age group and CRP level (r=0.038, P=0.471)*

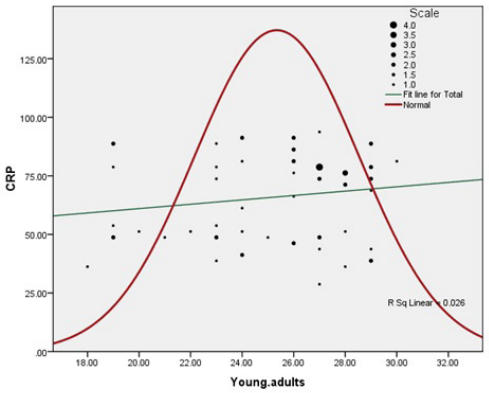

Fig. 2. *A weak positive correlation between young adult group and CRP level (r=0.026, P=0.392)*

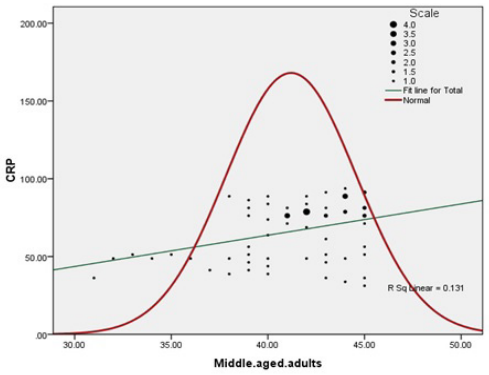

Fig. 3. *A week positive correlation between middle aged adults and CRP level (r=0.131, P=0.048)*

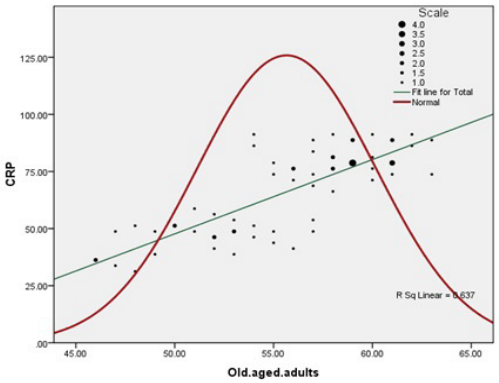

Fig. 4. *A moderate positive correlation between old-aged adults and CRP level (r=0.637, P=0.007)*

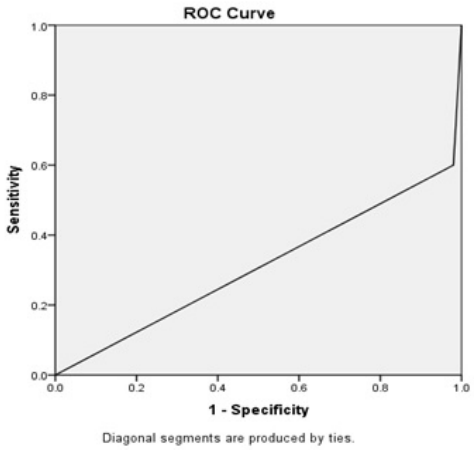

Fig. 5. *ROC curve of sensitivity and specificity.*

Discussion

The number of patients with COVID-19 is currently rapidly increasing globally, and asymptomatic patients are also the source of infection. COVID-19-related case fatality is also rapidly increasing.[8] COVID-19 is a new threat to populations, and treatment options need to be evaluated.[9] Early monitoring of key indicators was an important basis to guide treatment strategies, and early assessment of the severity of the patient's condition was of great value.[10] The new testing technology developed by QuantLase Imaging Lab helps in the early detection of COVID-19. The laser-based DPI technique is described as low-cost, user-friendly, and non-invasive, meaning mass testing can be conducted cheaply and efficiently. False positives are common in DPI, and repeat tests may be needed. A positive result means previous or other infection, though it may not be COVID-19. The principle of the laser-based DPI technique, based on optical-phase modulation, is that it can give a sign of infection within a few seconds. The procedure, known as DPI, uses lasers to identify COVIDd-19 infections within seconds. The test is done by taking a blood sample using a lancet needle, which is the same as the one used for diabetes. If it is negative, COVID-19 is ruled out. A positive DPI requires further RT-PCR, which is considered a standard for diagnosing COVID-19 in the UAE. The screening is conducted by assessing a nasal swab. This method is a real-time assessment to detect SARS-CoV-2 genetic material or RNA from a person's upper and lower respiratory specimens. CRP levels are correlated with the level of inflammation, and its concentration level is not affected by factors such as age, sex, and physical condition. This test is mandatory for patients with critical conditions who are in hospital care because the test is one of the indicators showing the body's reaction to the ongoing treatment. If the CRP, which is also recommended in the guidelines for COVID management,[11] is normal then the patient's body is reacting to the treatment positively, but if it is higher than required, checking the infection level in the body through other tests is needed.[12]

Conclusion

The proposed multiplex real-time RT-PCR methodology will enable highly sensitive detection of SARS-CoV-2 RNA. In the early stage of COVID-19, the CRP level is positively correlated with the positive PCR and could reflect disease severity, so it should be used as a key indicator for disease monitoring. CRP is a sensitive serological indicator used to evaluate the severity of COVID-19. The combined detection of the three indicators (RT-PCR, DPI, and CRP) are positively related to COVID-19 infection; therefore, these indicators will enable effective intervention measures to be implemented in time and the rates of severe illness and mortality to be reduced.

Competing Interests

The authors declare that they have no competing interests.

References

1. Taleghani N, Taghipour F. Diagnosis of COVID-19 for controlling the pandemic: A review of the state-of-the-art. Biosens Bioelectron. 2021 Feb 15; 174:112830. doi: 10.1016/j.bios.2020.112830. Epub 2020 Nov 27. PMID: 33339696; PMCID: PMC7694563
2. Al Hosany F, Ganesan S, Al Memari S, Al Mazrouei S, Ahamed F, Koshy A, Zaher W. Response to COVID-19 pandemic in the UAE: A public health perspective. J Glob Health. 2021 Mar 27; 11:03050. doi: 10.7189/jogh.11.03050. PMID: 33828834; PMCID: PMC8005306.
3. Borges LP, Martins AF, Silva BM, Dias BP, Gonçalves RL, Souza DRV, Oliveira MGB, Jesus PC, Serafini MR, Quintans JSS, Coutinho HDM, Martins N, Júnior LJQ. Rapid diagnosis of COVID-19 in the first year of the pandemic: A systematic review. Int Immunopharmacol. 2021 Dec;101(Pt

***Corresponding author:** Dr. Salah Eldin Omar Hussein. Department of Medical Laboratory Sciences, College of Health Sciences, Gulf Medical University, Ajman, United Arab Emirates. E-mail: dr.salaheldin@gmu.ac.ae*

A):108144. doi: 10.1016/j.intimp.2021.108144. Epub 2021 Sep 15. PMID: 34607235; PMCID: PMC8440261.
4. The United Arab Emirates' Government portal. Types of tests for detecting COVID-19 and testing for COVID-19. Available at: https://u.ae/en/information-and-services/justice-safety-and-the-law/handling-the-covid-19-outbreak/types-of-tests-for-detecting-covid-19-and-testing-for-covid19
5. MOHAP. COVID-19. Recent COVID-19 Information and Updates. Available at: https://mohap.gov.ae/en/covid-19
6. Ishige T, Murata S, Taniguchi T, Miyabe A, Kitamura K, Kawasaki K, Nishimura M, Igari H, Matsushita K. Highly sensitive detection of SARS-CoV-2 RNA by multiplex rRT-PCR for molecular diagnosis of COVID-19 by clinical laboratories. Clin Chim Acta. 2020 Aug;507:139-142. doi: 10.1016/j.cca.2020.04.023.
7. PureHealth. COVID-19: All You Need to Know About RT-PCR Tests and How They Can Be Conducted In The UAE Safely. Available at:https://darelhikmah.com/pcr_web/static/pure/purehealth.ae/all-you-need-to-know-about-rt-pcr-tests/index.html
8. Al Harbi M, Al Kaabi N, Al Nuaimi A, Abdalla J, Khan T, Gasmelseed H, Khan A, Hamdoun O, Weber S. Clinical and laboratory characteristics of patients hospitalised with COVID-19: clinical outcomes in Abu Dhabi, United Arab Emirates. BMC Infect Dis. 2022 Feb 8;22(1):136. doi: 10.1186/s12879-022-07059-1. PMID: 35135491; PMCID: PMC8822868
9. Ramphul K, Mejias SG. Coronavirus Disease: A Review of a New Threat to Public Health. Cureus. 2020 Mar 15;12(3):e7276. doi: 10.7759/cureus.7276. PMID: 32300496; PMCID: PMC7158591.
10. Wang L. C-reactive protein levels in the early stage of COVID-19. Med Mal Infect. 2020 Jun;50(4):332-334. doi: 10.1016/j.medmal.2020.03.007. Epub 2020 Mar 31. PMID: 32243911; PMCID: PMC7146693.
11. Ahnach M, Zbiri S, Nejjari S, Ousti F, Elkettani C. C-reactive protein as an early predictor of COVID-19 severity. J Med Biochem. 2020 Oct 2;39(4):500-507. doi: 10.5937/jomb0-27554. PMID: 33312067; PMCID: PMC7710381.
12. Nayak S, Acharjya B. VDRL test and its interpretation. Indian J Dermatol. 2012 Jan;57(1):3-8. doi: 10.4103/0019-5154.92666. PMID: 22470199; PMCID: PMC3312652.