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(RESEARCH ARTICLE)

Evaluation of Sars-Cov-2 infection in vaccinated persons: Case of the general hospital of Douala (Cameroon)

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Abstract

Coronavirus infection is a public health problem worldwide despite the implementation of several control measures and vaccination. The purpose of this study was to evaluate SARS-Cov-2 infection in vaccinated patients.

Methods: A cross-sectional study was conducted at the Douala General Hospital from January to June 2022. Patients of both sexes, aged over 18 years, vaccinated against SARS-CoV-2 were included. Information regarding socio-demographic data, clinical manifestations, and SARS-CoV-2 vaccination was collected by individual interview. Nasopharyngeal secretions were collected by swabbing and transported to the laboratory. SARS-CoV-2 was detected using a rapid diagnostic test (antigen test) and a molecular test targeting the ORF and N genes (Daan gene® kit). Data were analyzed using StatView v5.0 and GraphPad v5.03.

Results: A total of 62 patients were selected and women represented 64.5%. The mean age of the patients was 45.58 ± 13.14 with a predominance of the 40 to 50 year old age group. The patients had been vaccinated with four SARS-CoV-2 vaccines (Vaxzeria®, Jcovden-COVID-19 Vaccine Janssen®, Comirnaty Biontech-Pfizer® and Sinovac®); 50.9% of them had received the Janssen®. Viremia was higher in men aged 30 to 60 years and in those who received Janssen® vaccine. The mild form of the infection was the most common clinical presentation with 80.4% of cases. There was a delay of 3 to 5 months between vaccine administration and COVID 19 infection.

Conclusion: Most of the vaccinated persons developed mild forms of COVID-19 with a mean delay of 3 to 5 months; the viremia was higher in men, in those who received the Janssen® vaccine and in those aged 30 to 60 years. Vaccination remains an effective means of preventing severe forms of SARSCoV-2 infection.

Keywords: COVID-19; Post-vaccination infection; Douala; Hospital

1. Introduction

Severe acute respiratory syndrome coronavirus (SARS-CoV-2) is an enveloped ribonucleic acid (RNA) virus belonging to the Coronaviridae family [1]. It is the cause of coronavirus 2019 (COVID-19) and was declared a public health emergency of international concern in January 2020 and a pandemic in March 2020 [2]. Epidemiological data on the

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infection remain highly variable across continents and countries [3]. Worldwide by the end of June 2022, the pandemic had affected 224 countries and territories with 518801767 registered cases; in Africa 11859004 cases have been confirmed and in Cameroon 119 947 cases [3]. Vaccination (which began with Jenner, then Pasteur and developed during the XIXe and XXe centuries) is the most effective public health action that has made it possible to eliminate or greatly reduce the incidence of infectious diseases in general and the COVID-19 pandemic in particular [4,5]. The principle of vaccines is to induce protection against a given pathogen by educating the immune system, thus reducing the risk of complications and mortality in case of subsequent exposure to the infectious agent [5]. Different types of live attenuated, inactivated and gene fractions vaccines are currently available or under development [4,5]. Vaccination, which provides individual protection but also collective protection by group immunity, is however threatened by vaccine hesitancy maintained by controversies on its undesirable effects and its effectiveness, most of which have not been scientifically confirmed [6]. In January 2022, the prevalence of the population fully vaccinated against the SARS-CoV-2 virus was 53.3% in the world, 69.83% in Europe, 62.1% in the USA, 54.7% in Asia and 13% in Africa and 4.6% in Cameroon [7]. For the vaccines of Pfizer, Moderna and Astra-Zeneca currently authorized in France, the protection rates against the symptomatic forms of Covid-19 are 95%, 94% and 70% respectively [8–9]. Several mutations, some of which affect the gene coding for the Spike (S) protein, have appeared with the variants of concern; this protein is the key to recognition and the target of many approved vaccines [9]. Despite the implementation of vaccination, some individuals after vaccine doses are still infected with SARS-CoV-2 [10]. The increased transmissibility of the virus with the emergence of new vaccine-resistant variants raises questions of reinfection detectable by direct diagnosis [10]. With this in mind, the present study was conducted to assess SARS-CoV -2 infection in vaccinated individuals.

2. Methodology

2.1. Type and setting of study

This was a cross-sectional study conducted at the Douala General Hospital (DGH) from January to June 2022. Specimen collection was carried out in the various departments (outpatient, inpatient and laboratory) and included persons over 18 years of age vaccinated against SARS-CoV-2 and presenting a positive COVID test; the analysis of the specimens was carried out in the molecular biology unit of the clinical biology laboratory of this hospital

2.2. Recruitment and data collection

After informed consent was obtained, data collection was done by direct interview of participants using a pre-designed questionnaire. The variables collected were sociodemographic characteristics (age, sex, occupation), type of vaccination received and vaccination schedule (complete or incomplete), history of COVID-19 (date of illness, PCR test results, time interval between vaccination and illness), and severity of illness.

2.3. Collection of samples

Nasopharyngeal swabbing was performed for each participant using a swab eluted in a specific viral transport medium (VTM). The tubes were transported in triple packaging in a cooler containing a cold accumulator to the Molecular Biology unit.

2.4. Methods and techniques used

Table 1 Interpretation of results

Results	**Real-time PCR target**		
	ORF1ab (FAM)	**N (VIC)**	**Endogenous (Cy5)**
Positive	Ct ≤ 37	Ct ≤ 37	Ct ≤ or Ct >37 or absent
Negative	Ct > 37 or absent	Ct > 37 or absent	Ct ≤ 37
Doubtful	Ct ≤ 37	Ct > 37 or absent	Ct ≤ 37
	Ct > 37 or absent	Ct ≤ 37	Ct ≤ 37
Disabled	Absent	Absent	Absent

The search for the SARS-CoV-2 genome was performed by the Retro Transcriptase Polymerase Chain Reaction (RT-PCR) technique using the Daan gene Kit® for inactivation and extraction. Amplification targeting two ORF 1ab and N genes was performed in a thermal cycler (AmpliLab System™) with positivity threshold at 37 cycles.

2.5. Data analysis

Data were analyzed with StatView v5.0 (SAS Institute, Chicago, Inc., Illinois, and USA) and GraphPad v9.03 (GraphPad PRISM, San Diego, Inc., California, and USA) software. Pearson's Chi2 and Fisher's exact tests of independence were used to compare percentages between clinical groups. Univariate and multivariate logistic regression models were used to identify factors associated with COVID-19 infection. The independent variables were gender, age, and occupation, symptoms at admission, exposure, and presence of comorbidities. For this purpose, the odd ratio (OR) and its 95% confidence interval (95% CI) were calculated. The threshold of statistical significance was set at $p < 0.05$

3. Results

A total of 82 individuals were approached and 24 excluded for refusal to participate and lack of a molecular diagnostic test; 62 who agreed to participate were retained.

3.1. Socio-demographic characteristics of patients

The female sex (64.5%) and the age group 40-50 years were the most represented (Table 2). After grouping based on complete and incomplete vaccination, we note that no statistical difference in this table was observed ($p > 0.05$).

3.2. Types of vaccines administered

Patients had been vaccinated with four COVID-19 vaccines (Vaxzevria®, Janssen®, Comirrnaty Biontech® and Sinovac®), with 50.9% receiving the Janssen vaccine®. However, no statistically significant association was found between vaccination status and vaccine type ($p = 0.07$). The majority of participants had received a complete vaccination regimen (88.7%) (Table 2).

The main side effects reported after vaccination were local pain and fatigue found in thirteen and seven patients respectively.

3.3. Variation in relative viremia

- Depending on the sex, the Ct value was higher in males regardless of the gene (Figure 1-A).
- By age, the Ct value was higher in patients in the 30 to 30 years age group.
- Depending on the time of vaccination the mean Ct value of the ORF1ab gene was higher in patients who developed the disease before a full vaccination regimen (Figure 1-C).
- By vaccine type, viremia was higher in those who received Janssen® (Figure 1-D).

3.4. Clinical presentation

The 41 patients who were infected during the period of 3 to 5 months after the second dose of vaccine inoculation had a milder form of the disease compared with the other patients.

3.5. Factors associated with COVID-19 infection in vaccinated individuals

None of the factors assessed besides age greater than 60 years was associated with risk of COVID-19 infection (Table 3).

3.6. Correlation between time to disease after vaccine inoculation and clinical forms

On average, a delay of 3 to 5 months was observed between vaccine administration and SARS CoV-2 infection. There was no correlation between vaccine inoculation and disease occurrence (Table 4).

Table 2 Distribution of socio-demographic parameters according to vaccination status

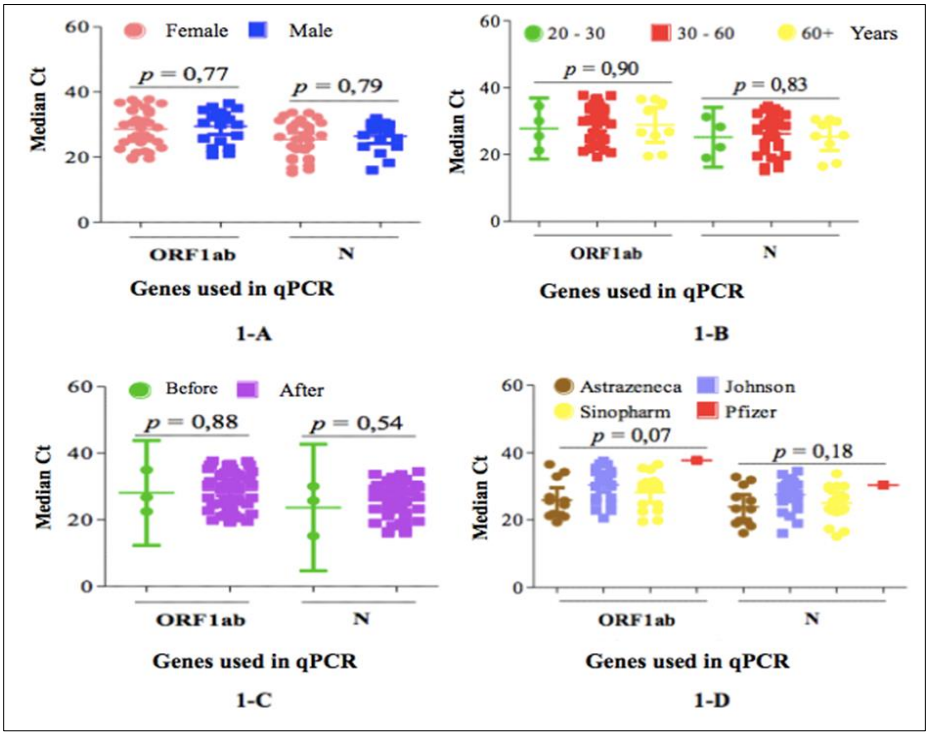
Variables		**Total (N = 62)**		**Incomplete vaccination (*n* = 7)**		**Complete vaccination (*n* = 55)**		***p-value***
		N	%	*N*	%	*N*	%	
Type	Female	40	64.5	6	85.7	34	61.8	0.404
	Male	22	35.5	1	14.3	21	38.2	
Age group (years) Mean 45.58±13.14	[20 - 30[	6	9.7	0	0.0	6	10.9	0.458
	[30 - 40[	14	22.6	1	14.3	13	23.6	
	[40 - 50[	18	29.0	2	28.6	16	29.1	
	[50 - 60[	15	24.2	4	57.1	11	20.0	
	[60 - 70[	5	8.1	0	0.0	5	9.1	
	[70 - 80[	3	4.8	0	0.0	3	5.5	
	[80 - 90[	1	1.6	0	0.0	1	1.8	
Level of study	Primary	4	6.4	0	0	4	7.3	0.444
	Secondary	23	37.1	4	57.1	19	34.5	
	Superior	36	56.5	3	42.9	32	58.2	
Marital status	Single	28	45.2	3	42.9	25	45.5	0.958
	Concubinage	1	1.6	0	0	1	1	
	Married	32	51.6	4	57.1	2	50.9	
	Widow(er)	1	1.6	0	0	1	1.8	
Activity sector	Private	16	25.8	2	28.6	14	25.5	0.859
	Public	46	74.2	7	71.4	41	74.5	
Type of vaccine	Vaxzevria®	14	22.6	3	42.9	11	20.0	0.07
	Janssen®	28	45.2	0	0	28	50.9	
	Comirnaty Biontech®	1	1.6	0	0	1	1.8	
	Sinovac®	19	30.6	4	57.1	15	27.3	

Table 3 Factors associated with COVID-19 infection in vaccinated individuals

Variables		**Workforce N**	**n (%)**	**Univariate analysis**		**Multivariate analysis**	
				ORb (95% CI)	**p-value**	**ORa (IC95%)**	**p-value**
Type	Female	36	33 (91.7)	1		1	
	Male	21	19 (90.5)	0.86 (0.13 – 5.64)	0.87	0.96 (0.09 – 9.64)	0.96
Age (years)		65	-	1.15 (1.02 – 1.29)	0.02*	1.12 (0.98 – 1.27)	0.09
Activity sector	Private	15	12 (80.0)	1		1	
	Public	42	40 (95.2)	5.00 (0.75 – 33.50)	0.09	2.46 (0.18 – 33.35)	0.49
Symptoms on admission	No	43	40 (93.0)	1		1	
	Yes	14	12 (85.7)	0.45 (0.07 – 3.02)	0.41	0.72 (0.04 – 13.86)	0.82
Loss of taste	No	53	49 (92.5)	1		1	
	Yes	4	3 (75.0)	0.25 (0.02 – 2.93)	0.27	0.56 (0.01 – 31.68)	0.77

Exhibition	No	6	5 (83.3)	1		1	
	Yes	51	47 (92.2)	2.35 (0.22 – 25.33)	0.48	1.57 (0.04 – 69.13)	0.82
Effects 2aires post-vaccine	No	39	36 (92.3)	1		1	
	Yes	18	16 (88.9)	0.67 (0.10 – 4.39)	0.67	0.77 (0.06 – 9.78)	0.84
Comorbidity	No	42	38 (90.5)	1		1	
	Yes	15	14 (93.3)	1.47 (0.15 – 14.34)	0.73	1.24 (0.06 – 26.60)	0.89

N = Number of persons vaccinated positive by PCR to COVID-19



Ct : Cycle Threshold; 1-A By gender; 1-B By age group; 1-C By vaccination period; 1-D By vaccine type

Figure 1 Variation in relative viremia

Table 4 Distribution according to time to disease onset and clinical presentation after the first dose of vaccine

Variables		**Total**	**Delay after vaccination**			***p-value***
			< 3 months	**3 - 5 months**	**≥ 6 months**	
Number N (%)		51 (100)	10 (19.6)	24 (47.1)	17 (33.3)	
Clinical form N (%)	Slight	41 (80.4)	9 (17.6)	17 (33.3)	15 (29.4)	0.54
	Moderate	6 (11.8)	1 (2.0)	4 (7.8)	1 (2.0)	
	Severe	4 (7.8)	0 (0.0)	3 (5.9)	1 (2.0)	

4. Discussion

This study was conducted to determine the frequency of infection in persons vaccinated against SARS-COV-2 received at the Douala General Hospital.

Concerning gender, we observed a predominance of women with 64.5% of cases, similar to the results observed in Italy by Palmieri et al. in 2022, i.e. 59.47% of women [11]. However, this parameter is variable as shown by the work of Brosh-Nissimov et al. in Israel in 2021 and Zhang et al. in 2022 in China who found a majority of cases in men [12, 13]. This difference could also be explained by the small sample size which reflects the low uptake of vaccination observed in Cameroon [3].

The age group most represented in our study was 40 to 50 years; Vassallo et al. in 2022 in France observed the greatest number of cases of infection in people over 60 years, probably because in that country vaccination was primarily reserved for the elderly [14].

The vaccines administered are variable according to the availability in the countries, in the case of the General Hospital, the patients had been vaccinated with four types of SARS-COV-2 vaccines, of which 50.9% had received the Janssen vaccine® for which the complete vaccination scheme was a single dose. In China, the majority of those vaccinated had received the inactivated vaccine Sinovac® with a significant difference ($p<0.01$) as shown in the work of Zhang et al. in 2022 [13]. Baltas et al. showed that most patients developed COVID-19 after the first dose of vaccination [15].

The results showed that the mean Ct value was lower for the N gene compared to the ORF1ab gene regardless of the variable used, however the difference was not statistically significant. Zhang et al. showed that the mean Ct value did not differ according to vaccination status, however Baltas show that when compared to unvaccinated patients, the relative viral loads are lower [13,15].

Age was a factor associated with the risk of COVID-19 infection in vaccinated individuals, this shows that old age puts vaccinated individuals at an increased risk of developing severe infection; biologically, the elderly are more vulnerable and can easily develop the severe forms [13].

The most common clinical manifestation was the mild form, and a delay of 3 to 5 months was observed between the administration of the second dose of vaccine and the infection of patients. Several authors have observed moderate or severe forms of the disease and on average a delay of more than one month between the administration of the vaccine and the admission of the patients to hospital; these data vary according to the type of vaccine, the group concerned and the vaccination status [8, 12, 13].

Limitations of the study

- Decrease in the number of COVID-19 cases in January 2022
- Small sample size

5. Conclusion

The study, which evaluated SARS-COV-2 infection in vaccinated individuals, found that most participants developed mostly mild forms of COVD-19, with higher viremia in men, in the 30-60 age group, and in those who received the Johnson and Johnson vaccine. Age was a factor associated with the risk of infection, and an average delay of 3 to 5 months was observed between vaccination and infection. Vaccination remains an effective means of preventing severe forms of SARS CoV-2 infection.

Compliance with ethical standards

Acknowledgments

We express our gratitude to all those who agreed to participate in this study.

Data availability

All data supporting these results can be found in the Molecular Biology Unit of the Clinical Biology Laboratory of the GHD.

Author contributions

All authors participated in the development of this manuscript and read and approved the final version.

Disclosure of conflict of interest

The authors declare no conflicts of interest.

Statement of ethical approval

The study was conducted in accordance with the ethical guidelines for research in Cameroon. We obtained research authorization from the administrative officials of the Douala General Hospital, and ethical clearance from the Institutional Human Health Research Ethics Committee of the University of Douala (No. 2985bCEI-Udo/04/2022/M).

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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