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ORIGINAL ARTICLE

Detection of SARS-CoV-2 IgG Antibodies in Individuals Following Infection and Vaccination

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Abstract

To contain the SARS-CoV-2 infection a number of measures including vaccination had taken to reduce virus transmission and mortality. Protection from a viral infection is mainly achieved by virus-neutralizing antibodies which are produced after infection or vaccination. But to what degree these can induce the production of neutralizing antibodies is poorly understood. To determine the development of SARS-CoV-2 IgG antibody production against spike protein after infection and vaccination. A prospective study was conducted from July 2021 to December 2021 at tertiary care hospital, Solapur. Based on the evidence of previous SARS-CoV-2 infection and status of vaccination, a total of 150 participants above 18 years of age were enrolled. A blood sample was collected for the serum to perform an Enzyme-linked immunosorbent assay (ELISA) using the ErbaLisa COVID-19 IgG kit. Chi-square test for goodness of fit was used to analyze the data. In this study, we have assessed the development of protective immunity and it was found that 89.33% (134/150) of participants had a detectable level of SARS-COV-2 IgG antibodies. Also, in the present study the development of antibodies following infection, after a first and second dose of vaccination is compared, and observed that SARS-COV-2 IgG antibodies were detected in 88% of participants following infection, in 84% of participants after the first dose, and in 96% after the second dose. Effective vaccination is an essential solution to decrease - the severity, transmissibility and the emergence of new variants.

Keywords: Covid antibody, Covid-19 immune response, SARS-CoV-2 IgG, vaccination

Introduction

Since December 2019, cases of viral pneumonia due to SARS-CoV-2 (Covid-19) emerged in Wuhan, China. [1] This highly contagious infection responsible for the worldwide Covid-19 pandemic holds challenges for the global health system in containing the spread as asymptomatic and pre-symptomatic individuals can also transmit the virus. [2] Also due to the lack of clinical evidence, there were no approved antiviral drugs available against SARS-CoV-2. [3] Hence a number of measures including social distancing, wearing face masks, hand hygiene, contact tracing, workplace closures, travel restrictions, vaccination etc. had taken to reduce virus transmission and mortality. [4] But the core of an effective disease containment strategy lies in the effective vaccination deployment. [5]

It is a well-known fact that natural viral infections can induce the antigen-specific immune response of B and T cells which are ultimately responsible for the production of virus-neutralizing antibodies. The same response can be achieved by the introduction of a vaccine containing a specific antigen that induces a desired neutralizing antibodies production. [2]

In SARS-CoV-2, a spike (S) glycoprotein has a receptor-binding domain (RBD) which is the main target of neutralizing antibodies [6] and the majority of the vaccines for COVID-19 aim to induce neutralizing antibodies against the viral S protein that prevents uptake through the human ACE2 receptor. [7] But to what degree natural infection and vaccination can induces the production of neutralizing antibodies are also important. Hence, this study aims to determine the development of SARS-CoV-2 IgG antibody production against spike protein after infection and vaccination.

Materials and method

A prospective study was conducted from July 2021 to December 2021 at tertiary care hospital, Solapur (Maharashtra, India) and approved by Institutional Ethical Committee.

Before commencing the study three groups were made as follows –

Group A – includes those unvaccinated patients who had been positive for SARS-CoV-2 infection by RT-PCR.

Group B – includes those who had the only first dose of the Covishield vaccine and have not been infected with SARS-CoV-2 to date.

Group C – includes those who had completed both doses of the Covishield vaccine and have not been infected with SARS-CoV-2 to date.

In each group, 50 participants with age 18 years and above were enrolled and written informed consent was obtained from all participants. So, a total of 150 participants were enrolled. Those who had SARS-CoV-2 infection after vaccination and vice versa were excluded from this study to discriminate whether the antibodies were due to the natural infection or vaccination.

On the 21st day of either infection or vaccination, a blood sample of 3cc was collected in a gel containing yellow top vacutainer by phlebotomy under all aseptic precautions from each participant. Then serum was separated by centrifugation and stored in a screw cap cryovial at -20°C until tested by enzyme-linked immunosorbent assay (ELISA).

Enzyme-linked immunosorbent assay (ELISA) was performed using ErbaLisa COVID-19 IgG kit having a sensitivity of 98.3% and a specificity of 98.1% which qualitatively detects IgG present in the human serum against spike protein. The test was performed as per the manufacturer's instructions. Results were reported qualitatively.

Results

Out of a total of 150 participants, 134 (89.33%) participants had SARS-CoV-2 IgG antibodies whereas 5 (3.33%) participants fall in the borderline zone and in 11 (7.33%) participants had SARS-CoV-2 IgG antibodies were absent. (Table 1)

Table 1. Seroprevalence of SARS-CoV-2 IgG Antibody

Total no of participants	Antibody detected	Antibody detected Borderline	Antibody not detected
150	134 (89.33%)	5 (3.33%)	11 (7.33%)

Table 2. Age-group-wise seroprevalence of SARS-CoV-2 IgG Antibody

Age Group in years (n=150)	Positive	Borderline	Negative	Total
18-35 years	49	3	4	56
36-50 years	40	0	4	44
51-65 years	34	0	2	36
>66 years	11	2	1	14
Total	134	5	11	150

Out of 150 participants, SARS-CoV-2 IgG antibodies were detected in 134 (89.33%) participants, of which 36.57% were from 18-35 years of age followed by 29.85% from 36-50 years of age, 25.37% from 51-65 years of age and 8.21% from ≥ 66 years of age. (Table 2)

In group A (n=50), 88 % (n=44) participants had IgG antibodies against SARS-CoV-2 whereas 2 % (n=1) participant showed borderline level of antibodies but 10% (n=5) participants were nil for SARS-CoV-2 IgG antibodies. (Figure 1)

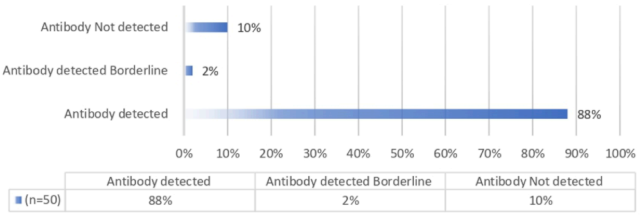

Fig 1. Seroprevalence of SARS-CoV-2 IgG antibody in group A

Similarly, in group B (n=50), 84% (n=42) participants had IgG antibodies against SARS-CoV-2 whereas 4 % (n=2) participants showed a borderline level of antibodies and 12 % (n=6) participants were negative for SARS-CoV-2 IgG antibodies. (Figure 2)

But in group C (n=50), none (n=0) of the participants remain behind to develop antibodies. In total (n=50), 96 % (n=48) of participants had IgG antibodies against SARS-CoV-2 whereas 4 % (n=2) participants remain at borderline. (Figure 3)

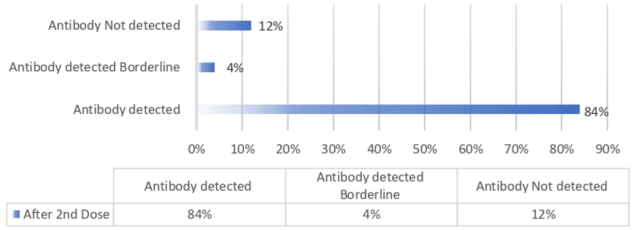

Fig 2. Seroprevalence of SARS-CoV-2 IgG antibody in group B

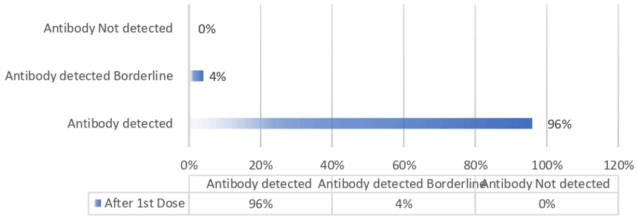

Fig 3. Seroprevalence of SARS-CoV-2 IgG antibody in group C

When these three groups (group A, group B and group C) were compared and analyzed statistically by chi-square test for goodness of fit, there was no statistically significant difference found.

Discussion

Natural infection exposes the viral proteins including spike protein to the immune system. Also, the majority of COVID-19 vaccines had viral S protein as a target against which immune response can be elicited by the host. But infection and vaccination present the spike protein to the immune system in a different way. Hence response of memory B cells that produce antibodies is also different. [8]

To access the development of these antibodies, serological tests are useful that can also estimate the extent of immunity in the community. [9,10]

In this study, we assessed the development of protective immunity and it was found that 89.33% (134/150) participants had SARS-COV-2 IgG antibodies. This shows the development of protective immunity in the community. The present study also compared the detection of antibodies following infection, after a first and second dose of vaccination, and observed that SARS-COV-2 IgG antibodies were detected in 88% of participants following infection (group A), in 84% of participants after the first dose (group B) and in 96% after the second dose (group C). A study by Lustig Y. et. al. (2021) [11] showed that 85-90% of infected individuals had antibodies while neutralizing and IgG antibodies in

96·5% and 99·9% of vaccinated participants.

Instead of having SARS-CoV-2 IgG antibodies in a significant number of participants from all groups, there was no statistically significant difference noted. So, why get vaccinated even after having antibodies from natural infection?

The natural infection leads to a pool of antibodies against not only spike protein but also other viral proteins that continued to grow in potency. That is because antibodies producing memory B cells evolve in lymph nodes over a period of time. [8] While vaccinations show significantly higher immunogenicity in infected as well as uninfected participants but stop evolving after a few weeks. [8,11,12] But some researchers noticed the unique properties of the vaccine responses in people who recovered from COVID-19 is that the level of antibodies was enormous compared to those following two doses of vaccine alone. This type of immunity may be referred to as "Hybrid immunity". [8]

Hybrid immunity produces a consistently higher level of antibodies compared with never-infected vaccinated people and the level of antibodies was more stable in such people. Such antibodies were able to neutralize immune-evading strains in a much better way. [8] Thus, it is crucial to get vaccinated irrespective of previous exposure status to COVID-19.

Limitations of the study include a small sample size and a lack of quantitative detection of antibodies.

Conclusion

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and the emergence of new variants are a grave threat to public health. Effective vaccination is essential to decrease - the severity, transmissibility and emergence of new variants. Now, with the successful development, evaluation and production of multiple vaccines, governments are turning towards vaccination as an essential solution to the pandemic. Given our findings, we propose that vaccines should be given to every individual irrespective of COVID 19 exposure in the past. Further data are needed to better understand the extent to which quantitative antibody responses are associated with COVID 19 infection and how concentrations of antibodies change with time.

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