Efficacy of Sinopharm® COVID-19 Vaccine in Hemodialysis Patients: A Preliminary Report

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Introduction. SARS-CoV-2 infection have been reported to have a greater mortality rate in adults receiving dialysis, as compared to general population. Hence, vaccination is very important in this vulnerable population group, in order to achieve an acceptable level of immunity. The aim of this study was to compare the level of anti-SARS-CoV-2 anti-spike protein receptor-binding domain IgG neutralizing antibody before and after vaccination with two doses of Sinopharm® vaccine, in patients undergoing hemodialysis.
Methods. Ninety patients on maintenance in-center hemodialysis received two doses of Sinopharm® COVID-19 vaccine with an interval of about 28 days. Anti-SARS-CoV-2 anti-spike protein receptor-binding domain IgG (Anti-RBD) neutralizing antibody was measured with an ELISA kit. All statistical analyses were performed by SPSS-26 software.
Results. The absolute mean (± SE) change in antibody titer following full-scheduled vaccination was 8.98 ± 1.49 µg/mL. The rate of seroconversion was 31.1% after two doses of vaccine. In addition, the rate of seroconversion was higher in those with a history of COVID-19 than in those without a history of COVID-19.
Conclusion. Conclusion. The administration of booster doses, doubling of the dose in each episode of vaccination schedule as well as combination of different vaccine platforms are recommended to increase COVID-19 vaccine efficacy in hemodialysis patients.

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INTRODUCTION

COVID-19 pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was emerged from Wuhan, China in 2019.[1] The disease may affect several organs, including respiratory system, and causes mild to severe symptoms and even results in death.[2]

The presence of underlying diseases and comorbidities, such as diabetes, advanced age, cardiovascular disorders, and particularly chronic kidney disease, can affect the disease severity and increase the risk of mortality and morbidities. The risk of death has been reported to be higher in patients undergoing routine hemodialysis.[3] Additionally, in-center hemodialysis patients are more likely to develop COVID-19, due to the need to visit relevant centers, several times a week for several hours[3]. In order to handle the pandemic with the current treatments, these patients have a priority to receive the currently available vaccines.[4]

The global efforts has given rise to four broad categories of vaccines: i) nucleic acid-based (mRNA) vaccines, such as those designed and manufactured

by Pfizer-BioNTech and Moderna companies ii) adenoviral vector- based vaccines, such as those launched by Astra-Zeneca, Sputnik V, and Johnson and Johnson, iii) protein subunit vaccines such as Soberana, Razi-CoV-Pars and Spikogen, and iv) vaccines that are based on the classic inactivated virus or protein subunit technologies such as Sinopharm and Bharat products[5].

The amount of antibody that targets the spike protein of the virus has been used as a measure of response to the vaccine, in healthy individuals.6 Patients with kidney diseases generally have compromised immunity and besides, diminished acquired immunity response could be anticipated following fully-scheduled vaccination in these patients.[7-9] However, a developing field of study is necessary, in the case of COVID-19 vaccination.

The patients in phase 3 studies who received the following mRNA vaccines showed improved seroconversion and vaccine-induced immunity preventing COVID-19: BNT162b2: 95 percent; mRNA-1273: 94.1 percent and ChAdOx1 nCoV19: 70.4 percent.[7-9] The existing vaccination data for this vulnerable subset of patients have been collected by a recent meta-analysis.[10] Its findings revealed that, following the first and second doses of the vaccine, the overall rate of immunogenicity in the patient on maintenance hemodialysis was 41 percent and 89 percent, respectively. The Oxford-AstraZeneca ChAdOx1 nCoV-19, mRNA vaccines, BNT162b2, and mRNA-127310 COVID-19 were included in these studies. Diabetes was listed as a risk factor for non-response. [10]

Inactivated and protein subunit vaccines appear to have the advantage of being significantly safer and more easily available for broader patient populations, in low and middle-income countries. However, there is the lack of evidence, regarding the use of these vaccines in patients with end-stage kidney disease (ESKD), and other immunocompromised groups.[11-13]. In this regard, studies that aim to evaluate any aspect of immune responses, induced by such SARS-CoV-2 vaccines, will contribute to the expanding body of evidence.

Many researchers use repeated ELISA measurements, to track changes in circulating antibodies against the viral spike (S) protein, in order to assess the effectiveness of the COVID-19 vaccinations, in ESKD patients.[6]

According to recent findings, antibody responses to the routine COVID-19 vaccination, with Pfizer/BioNTech and Astra-Zeneca vaccines, are suboptimal in hemodialysis (HD) patients, although some individuals were able to elicit satisfactory antibody responses.[14] To the best of our of knowledge, data on the efficacy and safety profile of the Sinopharm® inactivated vaccine, in hemodialysis patient, are limited. Therefore, the current study aims to evaluate antibody responses to Sinopharm® vaccine, in a cohort of patients receiving in-center maintenance hemodialysis in Tehran, Iran.

MATERIALS AND METHODS

Participants

The current study was carried out between March and September 2021 in Tehran, Iran. It is a multi-centre cross-sectional survey. The study protocol was approved by the local ethics committee at Shahid Beheshti University of Medical Sciences. The study participants included patients undergoing in-centre maintenance haemodialysis in Tehran, and participants were selected by using a simple consecutive sampling. A written informed consent was signed by all participants, at the time of enrolment. A positive history of treatment with immunosuppressive medications, splenic dysfunction, HIV/AIDS, active malignancies, hematopoietic stem cell transplantation and a prior injection of any of the COVID-19 vaccine, were all considered as exclusion criteria. Baseline characteristics of eligible participants (n = 90) including demographics, laboratory findings, haemodialysis schedule as well as history of prior -COVID-19 (based on the participants' statement) were recorded.

Vaccine

In this study, there was 4 to 6 weeks interval between the two doses of Sinopharm® vaccine . All safety measures were implemented in accordance with the manufacturer's instructions. The public health organization for Tehran's northern region, Shemiranat Health Network, provided the vaccines to the collaborating hospitals. Vaccinations were performed according to the public health authority protocols. The establishment of the cold chain was observed meticulously and strictly and the manufacturer name, batch number and date of injection were controlled and recorded in the

Iranian National COVID-19 Vaccine Database, along with the name and national identity number of the patients, for each participant. All patients were monitored for at least 30 minutes following injection.

Laboratory Assessments

Blood samples were taken for serologic tests, 24 hours prior to the first dose and 4 to 5 weeks after the second dose of the vaccination. A trained laboratory technician or a nurse collected 2 mL of whole blood for the pre-vaccination biochemical assays after 10 to 12 hours of fasting. Serum levels of albumin, vitamin D, triglycerides, total cholesterol, haemoglobin, ferritin, total iron binding capacity, lymphocytes, polymorphonuclears, and white blood cells were also measured at the beginning of the study. Anti-SARS-CoV-2 anti-spike protein receptor-binding domain IgG (Anti-RBD) neutralizing antibody was measured with an enzyme-linked immunoassay (ELISA) kit, produced by Pishtazteb®, Tehran, Iran. The minimum threshold for seropositivity was determined based on the manufacturer instruction. The KT/V formula (dialysis clearance of urea (K) multiplied by dialysis time (T), divided by the volume of distribution of urea (V)) was also used, to evaluate the adequacy of dialysis.

Statistical Analysis

In the present study, SPSS version 26 software was used for all statistical analyses. The statistical significance was considered as a *P* value of < .05.

The distribution of qualitative variables between groups at each time point was compared by Chi-square or Fisher's exact tests. The Shapiro-Wilk test was initially used to assess the normality of the distribution, for quantitative variables. The distribution of quantitative variables, within each group, from the begin to the end of the study, as well as the distribution of quantitative variables, between groups, at each time point, were compared, using one-way analysis of variance (ANOVA).

The primary end-point was the rate of seroconversion of anti-RBD, at the antibody titre cut-off, specified by the manufacturer of the laboratory kit ($\geq$ 2.5 µg/mL), following vaccination versus baseline.

Continuous variables which were parametric and non-parametric were reported as mean (± standard error [SE]) and medians (with interquartile range), respectively. D'Agostino and Pearson test assessed normality. In the case of ordinal data, the paired values at baseline, and following each sampling, were examined by the non-parametric Friedman test. Fisher's exact test was used for contingency tables.

RESULTS

Table 1 lists the demographic and biochemical data of the participants, which were collected at the beginning of the study, and before the injection of first dose of Sinopharm® vaccine.

Table1. Baseline Demographic and Biochemical Variables of Study Participants

Variables	Frequency(%) (Mean ± SE)
Age, y	61.43 ± 1.66
Dialysis Length, mo	41.91 ± 39.28
BMI, kg/m^2	24.45 ± 0.51
Total Cholesterol, mg/dL	144.37 ± 9.93
TG, mg/dL	130.33 ± 7.94
Albumin, g/dL	4.24 ± 0.04
Antibody Before Vaccine, µg/mL	2.7 ± 0.8
Antibody After Vaccine, µg/mL	11.68 ± 1.7
Change of Antibody, µg/mL	8.98 ± 1.49
Vitamin D, ng/mL	36.18 ± 1.9
Hb, g/dL	11.30 ± 0.15
Fe, mmol/L	92.89 ± 9.37
TIBC, umol/L	332.67 ± 11.04
Ferritin, ng/mL	380.56 ± 34.14
WBC, Cell/µL	6517.44 ± 242.43
PMN	62.98 ± 1.26
Lymph	29.03 ± 1.12
PTH, pg/mL	302.14 ± 27.06
Kt/V	1.32 ± 0.02
Sex	
Male	64 (71.1)
Female	26 (28.9)
History of COVID-19	
NO	62 (68.88)
YES	28 (31.11)
ESRD cause	
DM & HTN	71 (78.9)
GN, SLE	10 (11.1)
ADPKD	5 (5.6)
Others	4 (4.4)
Transplant	
YES	10 (11.1)
NO	80 (88.9)

Abbreviations: BMI, body mass index; TG, triglyceride; Hb, hemoglobin; Fe, iron; TIBC, total iron binding capacity; WBC, white blood cell; PMN, polymorphonuclear leukocytes; iPTH, intact parathyroid hormone; DM, diabetes mellitus; HTN, hypertension; GN, glomerulonephritis; SLE, systemic lupus erythematosus; ADPKD, autosomal dominant polycystic kidney disease.

Ninety hemodialysis patients, with a mean age of 61.43 ± 1.66 years, were included in the study, 71.1% of whom were male. A prior history of COVID-19 was found in 31.11% of patients.

The results demonstrated that only a confirmed history of COVID-19, prior to vaccination, was related to the generation of antibodies, whereas other parameters such as triglyceride, albumin, vitamin D and KT/V had no correlation with antibody generation. The mean (± SE) absolute change in antibody titer following vaccination was 8.98 ± 1.49 µg/mL (Table 1).

Prior to vaccination, 78.8 percent of the participants were seronegative, i.e., had antibody titers below the threshold value specified by the kit (< 2.5 µg/mL) and 21.1% were seropositive (antibody titers ≥ 2.5 µg/mL). After receiving two vaccine doses, 47.7 percent of the participants were still seronegative. (Table 2). Therefore, the rate of seroconversion was 31.1% following full vaccination.

According to McNemar test, a higher percentage of participants with a self-reported history of symptomatic COVID-19 were seropositive, following vaccination, compared to those who did not report such a history ($P < .05$) (Table 3).

As shown in Figure, patients with prior history of COVID-19 had experienced significantly higher seroconversion rate of anti-SARS-CoV-2 antibody, following receiving two doses of Sinopharm® vaccine.

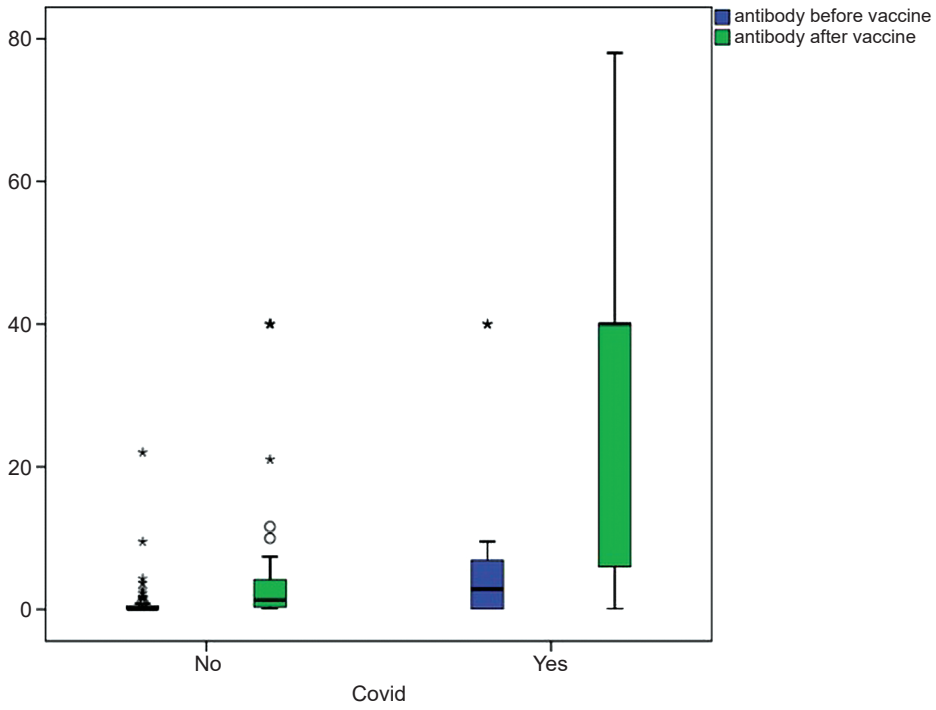
Table 3. Frequency of Cut-off Antibody Titer in Participants With or Without History of COVID -19 Before and After Receiving 2 Doses of Sinopharm Vaccine

Covid-19 History	Post-vaccination Serology (n (%))		*P**
	Negative†	Positive‡	
No	40 (44.44)	22 (24.44)	.001
Yes	4 (4.44)	24 (26.66)	

*McNemar Test
†< 2.5 µg/mL
‡ ≥ 2.5 µg/mL

Table 2. Frequency and Percent of Antibody Titers in Participants Before Receiving the First Dose and After Two Doses of Sinopharm Vaccine

Cut off Antibody Titer	Before the 1st Vaccine Dose (n (%))	After the 2nd Vaccine Does (n (%))
Negative (< 2.5 µg/mL)	71 (78.8)	43 (47.7)
Positive (≥ 2.5 µg/mL)	19 (21.1)	47 (52.2)



Anti-SARS-CoV-2 Antibody Before and After Receiving 2 Doses of Sinopharm Vaccine

DISCUSSION

The low efficacy of immunization schedules is a common and crucial issue in patients receiving hemodialysis. However, in a hemodialysis cohort, seroconversion rates of 71 to 97 percent have been observed, following vaccination with mRNA and adenoviral vector-based COVID-19 vaccines.[15] By contrast, data on Sinopharm® vaccine seroconversion rate in hemodialysis patients are scarce.[16,17]

In addition to numerous variations in COVID-19 vaccine and immunization schedules, there are several variations in the serologic assays, used to determine the effectiveness of the vaccinations. Given such diversities and differences, small numbers of clinical trials have been carried out to examine the effectiveness of different types of COVID-19 vaccines in individuals with kidney diseases. To the best of our knowledge, there is not an agreement on the best immunizations for hemodialysis patients.[15-18]

Center-based maintenance hemodialysis patients are required to visit a center, at least three times per week. As a result, this group of patients are essentially uncapable of adhering to social distancing, which is recommended during the pandemic. However, the majority of participants in this cohort, were seronegative prior to vaccination, indicating that COVID-19 vaccination is required in such high-risk individuals.

Our findings indicate that, a positive self-reported history of COVID-19 was the only baseline factor to have a statistically significant impact on the rate of seroconversion, following fully-scheduled immunization. Other factors, including body mass index, triglycerides and albumin, did not have any effect on the result.

Age, gender, underlying renal illnesses, and therapeutic regimens are a number of patient factors, that could have an impact on the rate of acquired immunity after vaccination. Poor generation of cell-mediated immunity or low seroconversion rate, may call for the launch of a new vaccine platform or further booster doses.[19]

In our study, 78.8% of the participants were seronegative prior to vaccination, with antibody titers below the cutoff value, provided by the reference kit threshold value (2.5 µg/ml). After receiving two doses of the vaccine, 47.7 percent of participants did not show any evidence of seroconversion. Hence, the rate of seroconversion was 31.1 percent following full vaccination.

The review of current literature revealed that the results of COVID-19 vaccinations in hemodialysis patients, are extremely diverse. Guillermo *et al.* demonstrated the safety and efficacy of Sputnik V vaccine in hemodialysis patients.[20] In contrast, Holt *et al.* recommended that all hemodialysis patients receive a booster dose of Sinopharm® vaccine, 3 months after the standard two doses vaccination. The authors believed that the vaccination is well tolerated, irrespective of levels of antibody production, with a potential survival benefit.[21] According to Giot *et al.*, hemodialysis patients who received an mRNA vaccine, developed a significant antibody response, and a history of SARS-CoV-2 infection was linked to a better post-vaccination immunological response.[22]

Similarly, Tillmann *et al.* found significant rates of seroconversion following two doses of SARS-Cov-2 vaccination, in patients on maintenance hemodialysis. In this study, failure of seroconversion was higher in patients who were concurrently receiving immunosuppressive agents, and they suggested additional studies on the effects of age and other confounding factors.[23] The post-vaccination humoral response against SARS-CoV-2 has been suggested to be significantly influenced by the prior history of COVID-19.[22-24]

The uremic environment may have an impact on the effectiveness of vaccination. Greater hemodialysis adequacy, i.e., higher KT/V, has been linked to enhanced vaccination-induced antibody response, according to experiences on the hepatitis B virus.[25] However, our study failed to prove such association and future research seems necessary in this regard.

One of the main limitations of our study was the relatively small sample size. In addition, the length of the follow-up was short and the persistency of acquired immunity, following vaccination, was not assessed. Future research with larger sample size and longer follow-up period is recommended, to assess the safety and efficacy of Sinopharm® vaccine, in hemodialysis patients. Furthermore, studies on cell-mediated immunity, as well as other serologic assays are essential, to evaluate the efficacy of vaccination in these patients.

CONCLUSION

In patients receiving routine hemodialysis, the Sinopharm® COVID-19 vaccine, administered in two doses, was associated with a modest rate of seroconversion. Patients with a prior history of COVID-19, who received two doses of Sinopharm® vaccine, developed higher antibody titters. Administration of one booster dose, doubling the vaccine dose in each episode, as well as combining vaccines from different platforms, are some of the future practical strategies that can be recommend to increase the efficacy of COVID-19 vaccines in haemodialysis patients.

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CONFLICT OF IINTEREST

Nil.

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