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Short Report

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Neutralizing potency of COVID-19 vaccines against the SARS-CoV-2 Omicron (B.1.1.529) variant

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Abstract

Background: We carried out a literature search for summarizing currently published evidence on severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Omicron (B.1.1.529) variant neutralizing properties of serum or plasma collected from recipients of coronavirus disease 2019 (COVID-19) vaccines.

Methods: An electronic search was conducted in Medline and Scopus, using the keywords “vaccine” AND “Omicron” OR “B.1.1.529” AND “SARS-CoV-2” AND “neutralization” OR “antibodies”, with no language or date limits (i.e., up to December 27, 2021). Studies with complete information on neutralization properties of COVID-19 vaccines against the Omicron variant, with or without the adjunctive effects of booster vaccine doses, were included.

Results: Our final analysis included 10 published studies. In all, decreased neutralisation of SARS-CoV-2 Omicron B.1.1.529 variant was evidenced in post-vaccination samples, ranging between -4.3 folds to absence of neutralization compared to an ancestral SARS-CoV-2 strain. In all studies the COVID-19 vaccine booster dose was effective to elicit sustained enhancement of SARS-CoV-2 Omicron B.1.1.529 neutralisation, with such increase being comprised between 10-42 folds compared to the pre-booster period.

Conclusion: Vaccine boosters seem strongly advisable for limiting the risk of SARS-CoV-2 Omicron (B.1.1.529) breakthrough infections.

Introduction

The recent emergence of a new variant of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) called Omicron (B.1.1.529) has raised paramount concerns in scientific and medical communities due to the presence of several mutations in the spike protein, many of which are located within the receptor binding domain (RBD).¹ Some of these mutations were found to have a substantial influence on host cells receptor and anti-SARS-CoV-2 antibodies binding,² which may then impact infectivity and neutralizing antibodies escape, thus potentially magnifying the risk of COVID-19 (coronavirus disease 2019) vaccine breakthrough. We have hence carried out a scientific literature search, aimed at summarizing the currently published evidence on Omicron variant neutralizing properties of serum or plasma collected from recipients of COVID-19 vaccines.

Materials and Methods

We carried out an electronic search in Medline and Scopus, using the keywords “vaccine” AND “Omicron” OR “B.1.1.529” AND “SARS-CoV-2” AND “neutralization” OR “antibodies”, with no language or date limits (i.e., up to December 27, 2021). Title, summary and (eventually) full text of all documents identified based on these search criteria were scrutinized, and those reporting complete information on the neutralization properties of COVID-19 vaccines against the SARS-CoV-2 Omicron (B.1.1.529) variant, with or without the adjunctive effects of booster vaccine doses administrated after completing a primary vaccination cycle, were included in our analysis. Due to the wide heterogeneity and scarce comparability of commercial immunoassays for measuring anti-SARS-CoV-2 antibodies, only studies using live or pseudotyped virus neutralization assays were retained. The reference list of all documents was also analyzed for identifying other potentially eligible investigations.

The following data were retrieved from all included studies: type of vaccine(s) used for primary vaccination, type of assay used for studying serum or plasma neutralizing properties, decreased neutralization of Omicron (B.1.1.529) variant compared to an ancestral strain and/or the currently endemic Delta variant, type of vaccine used for administering the homologous booster COVID-19 vaccine dose and, finally, increased level of Omicron (B.1.1.529) neutralization achieved after administering the booster dose.

Results

Overall, 37 items could be originally detected based on our search criteria, and 6 more could be identified from the reference lists, thus leading to 43 potentially eligible studies. Nonetheless, 33 of such documents ought to be omitted since they did not fulfil our aforementioned search criteria. Our final analysis could thus only include 10 published studies (Table 1),³⁻¹² which used the following vaccines: Pfizer/BioNTech BNT162b2 in 7 studies, Moderna mRNA-1273 in 3 studies, AstraZeneca ChAdOx1, Johnson & Johnson Ad26.COV2.S and Sinovac CoronaVac in 2 studies, whilst Sinopharm BBIBP-CorV, Novavax NVX-CoV2373 and Sputnik V vaccines were only used in 1 study, respectively. Live and pseudotyped virus neutralization assays were used in 3 and 6 studies, respectively, whilst the remaining study used a hACE2 (angiotensin converting enzyme 2) receptor binding test. Six out of these 10 studies described also the neutralizing activity achieved after administering a homologous vaccine booster dose (Table 1).

In all included studies, a decreased neutralisation of SARS-CoV-2 Omicron B.1.1.529 variant was evidenced in post-vaccination samples, ranging between -4.3 folds to absence of neutralization compared to an ancestral SARS-CoV-2 strain, and between -2.1 folds to absence of neutralization compared to the Delta SARS-CoV-2

variant, respectively (Table 1). For vaccines used in ≥ 3 studies, decreased neutralisation of SARS-CoV-2 Omicron B.1.1.529 compared to an ancestral strain was comprised between 22-127 folds in Pfizer/BioNTech BNT162b2 recipients, and between 9-122 in those receiving Moderna mRNA-1273, respectively. In all studies the COVID-19 vaccine booster dose was effective to elicit a sustained enhancement of SARS-CoV-2 Omicron B.1.1.529 neutralisation, with such increase being comprised between 10 and 42 folds compared to the pre-booster period (Table 1).

Conclusions

The results of this preliminary analysis of currently available research reveal that the neutralizing potency of all COVID-19 vaccines seems to be considerably reduced against the newly emerged SARS-CoV-2 Omicron (B.1.1.529), though the administration of vaccine booster doses is seemingly effective to substantially restore post-immunization efficacy against this new and highly mutated lineage. Vaccine boosters seem hence strongly advisable for limiting the risk of SARS-CoV-2 Omicron (B.1.1.529) breakthrough infections, especially in fragile populations or in those at higher risk of infection (e.g., immunocompromised patients).

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CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data available on request.

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Table 1. Neutralizing potency of coronavirus disease 2019 (COVID-19) vaccines against the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Omicron (B.1.1.529) variant

Authors	Primary vaccination			Booster vaccine dose	
	Vaccines; sample collection	Neutralization assay	Reduced Omicron neutralization (folds)	Vaccines; sample collection	Increased Omicron neutralization after booster (folds)
Dejnirattisai W et al., 2021 ³	2×ChAdOx1 or 2×BNT162b2; ~28 days	Live virus neutralization assay	Vs. ancestral strain: ChAdOx1: ↓×13.3; BNT162b2: ↓×29.8 Vs. delta variant: ChAdOx1: ↓×5.2; BNT162b2: ↓×25.1	No	-
Ai J et al., 2021 ⁴	2×BBIBP-CorV; ~14 days	Pseudotyped virus neutralization assay	Vs. ancestral strain: BBIBP-CorV: ↓×11.6; Vs. delta variant: BBIBP-CorV: ↓×7.9	1×BBIBP-CorV; 14-28 days	BBIBP-CorV: ↑×9.6
Garcia-Beltran WF et al., 2021 ⁵	2×BNT162b2 or 2×mRNA-1273; <3 months	Pseudotyped virus neutralization assay	Vs. ancestral strain: BNT162b2: ↓×43; mRNA-1273: ↓×122	1× BNT162b2 or 1× mRNA-1273; < 3 months	BNT162b2 ↑×27; mRNA-1273: ↑×19
Doria-Rose NA. et al., 2021 ⁶	2×mRNA-1273; ~14 days	Pseudotyped virus neutralization assay	Vs. ancestral strain: mRNA-1273: ↓×8.9	1×mRNA-1273; 14 days	mRNA-1273: ↑×12.6
Schmidt F et al., 2021 ⁷	2×BNT162b2 or 1× Ad26.COV2.S; ~1.3 month	Pseudotyped virus neutralization assay	Vs. ancestral strain: BNT162b2: ↓×127; Ad26.COV2.S: No neutralization	1×BNT162b2 or 1× Ad26.COV2.S; ~28 days	BNT162b2: ↑×42.1; Ad26.COV2.S: unavailable
Cameroni e et al., 2021 ⁸	2×BNT162b2 or 2×mRNA-1273 or 2×ChAdOx1 or 1× Ad26.COV2.S; 2× Sinovac; 2× Sptunik; 14-28 days	Pseudotyped virus neutralization assay	Vs. ancestral strain: BNT162b2: ↓×44; mRNA-1273: ↓×33; ChAdOx1: ↓×36; Ad26.COV2.S: No neutralization; Sinovac: No neutralization; Sptunik: No neutralization	No	-
Lu L et al., 2021 ⁹	2×BNT162b2 or 2× Sinovac; ~1 month	Live virus neutralization assay	Vs. ancestral strain: BNT162b2: ↓×38.7; Sinovac ↓×4.3 Vs. delta variant: BNT162b2: ↓×21.0; Sinovac ↓×2.1	No	-
Cele S et al., 2021 ¹⁰	2×BNT162b2; 10-63 days	Live virus neutralization assay	Vs. ancestral strain: BNT162b2: ↓×22	No	-
Muik A et al., 2021 ¹¹	2×BNT162b2; ~21 days	Pseudotyped virus neutralization assay	Vs. ancestral strain: BNT162b2: ↓×22.8 Vs. delta variant: BNT162b2: ↓×10.4	1×BNT162b2; ~1 month	BNT162b2: ↑×23.4
Mallory R et al, 2021 ¹²	2×NVX-CoV2373; ~14 days	hACE2 receptor binding test	Vs. ancestral strain: NVX-CoV2373: ↓×8.2 Vs. delta variant: NVX-CoV2373: ↓×2.8	1×NVX-CoV2373; ~28 days	NVX-CoV2373: ↑×14.8

Vaccines legend: AstraZeneca ChAdOx1 (adenovirus-based); Johnson & Johnson Ad26.COV2.S (adenovirus-based); Moderna mRNA-1273 (mRNA-based); Novavax NVX-CoV2373 (recombinant spike protein vaccine); Pfizer/BioNTech BNT162b2 (mRNA-based); Sinopharm BBIBP-CorV (inactivated); Sinovac CoronaVac (inactivated); Sputnik V vaccine (adenovirus-based).