SARS-CoV-2 mRNA Vaccines with Broad Neutralizing Activity and Protective Efficacy

Lanying Du
Professor, Institute for Biomedical Sciences, Georgia State University, Atlanta, GA, USA

Abstract:

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused the Coronavirus Disease 2019 (COVID-19) pandemic, resulting in devastating economic and human losses. This virus has infected at least 779-million people, including more than 7.1-million deaths. The constant infection of the virus, particularly SARS-CoV-2 Omicron variant and related subvariants, with increasing human cases calls for a consistent need of safe and effective vaccines against emerging variants. The surface spike (S) protein of SARS-CoV-2 plays a critical role in viral infection and pathogenesis, thereby serving as a key target for development of COVID-19 vaccines. The mRNA technology has proven to be a unique tool for the rapid development of efficacious vaccines against viral pathogens, particularly SARS-CoV-2. Here, we designed several mRNA vaccines targeting the S protein of SARS-CoV-2 Omicron subvaraints, and evaluated their immunogenicity, neutralizing activity, and protective efficiency in a mouse model. Our results showed that the mRNA vaccines, which were encapsulated with optimal lipid nanoparticles (LNPs), generated the particle sizes ideal for inducing effective immune responses. They elicited robust S-specific antibody responses, broadly neutralizing all SARS-CoV-2 Omicron subvariants tested. The mRNA vaccines exhibited strong protective efficacy, protecting transgenic mice from challenge with SARS-CoV-2 Omicron subvariant(s), and the level of protection was associated with the serum neutralizing antibodies. Collectively, these results demonstrate strong potential for development of the mRNA vaccines against Omicron subvariants of SARS-CoV-2 with current and future threats.

Keywords:

COVID-19, SARS-CoV-2, spike protein, mRNA vaccines.