RESEARCH ARTICLE

Echocardiographic assessment of left ventricular function after COVID-19 vaccination in adults

Hala Ahmed Mohamed Ahmed Wahdan, Reda Biomy, Wael Anwer Haseeb

Abstract

Objectives: To assess left ventricular function by conventional and speckle tracking echocardiography in subjects having received coronavirus disease-2019 vaccine.

Method: The cohort study was conducted from April 2021 to April 2022 at the Department of Cardiology, Kafrelsheikh University Hospital, Egypt, and comprised adults of either gender who had received coronavirus disease-2019 vaccine. Detailed history was noted before clinical assessment, electrocardiogram and echocardiography, which were done at baseline and after two weeks of the last vaccine dose. Apical 4, apical 3 and apical 2 strains were obtained to get the global longitudinal strain. Data was analysed using SPSS 20.

Results: Of the 100 subjects, 50(50%) each were males and females. The overall mean age was 39.20±14.57 years. There were 16(16%) subjects with diabetes mellitus and 21(21%) with hypertension. Regarding vaccine distribution, 34(34%) had received AstraZeneca AZD1222, 31(31%) had BioNTech Pfizer vaccine BNT162B2 and 35(35%) had Sinopharm Beijing Institute of Biological Products BBIBP-CorV. The global longitudinal strain before and after vaccination did not show a significant difference (p<0.063). There was no significant variation in global longitudinal strain between the various vaccination types (p=0.584).

Conclusion: The studied vaccines had similarly acceptable safety profiles regarding left ventricular functions.

Keywords: COVID-19, Myocarditis, Echocardiography, Electrocardiography, Myocardial Infarction, Cardiology.

DOI: 10.47391/JPMA.EGY-S4-47

Introduction

The coronavirus disease-2019 (COVID-19) began in 2019 as a result of the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2).[1] There are varying degrees of clinical severity of COVID-19. The most typical clinical picture includes myalgia, dry cough, tiredness, and headache. Some patients also present with gastrointestinal (GI) symptoms.[2] Also, 20% of COVID-19 patients go on to have severe respiratory disease.[3] Complications of COVID-19 include respiratory failure, myocarditis, renal failure, sepsis and end-organ damage[4] The mortality rate was predicted to be 3-4%, and the global economy carried a significant burden.[5]

The COVID-19 vaccines were developed quickly in December 2020 to benefit humanity and help restrain the economic burden of a country.[6] Many vaccines are currently in development. There are many different types of vaccines, including live or inactivated viruses, recombinant proteins, vectored shots, RNA vaccines, and DNA vaccines.[7] Many vaccines have been approved, including inactivated vaccines, like Beijing Institute of Biological Products (BBIBP)-CorV Sinopharm and Johnson & Johnson (JNJ)-78436735 vaccines with 79% and 66% efficacy, respectively, vectored vaccines, like Oxford University-AstraZeneca vaccine AZD1222 and Gamaleya Sputnik Gam-Covid-Vac vaccines with 62-90% and 92% efficacy, respectively, and ribonucleic acid (RNA) vaccines, like BioNTech Pfizer BNT162B2 and messenger RA (mRNA)-1273 Moderna vaccines with 95% and 94.5% efficacy, respectively.[8] There are common mild side effects of these vaccines.[9] There are also case reports of serious complications, like anaphylactic shock[10], myocarditis,[11,12] myocardial infarction (MI),[13,14] Guillain-Barre Syndrome (GBS),[15] generalised rash,[16] arm rash, called the COVID arm,[17] cerebral venous sinus thrombosis,[18] deep venous thrombosis (DVT),[19] Kounis syndrome,[20] and acute kidney injury (AKI).[21]

The current study was planned to assess left ventricular (LV) functions by conventional and speckle tracking echocardiography in those having received any of the COVID-19 vaccines.

Subjects and Methods

The cohort study was conducted from April 2021 to April 2022 at the Department of Cardiology, Kafrelsheikh University Hospital, Egypt, and comprised adults of either gender who had received coronavirus disease-2019

Department of Cardiology, Kafrelsheikh University, Egypt.

Corrospondience: Hala Ahmed Mohamed Ahmed Wahdan
email: hala_wehdan@med.kfs.edu.eg

vaccine. The sample was raised after approval from the institutional ethics review committee. Those with impaired systolic function (ejection fraction [EF] <40%), acute coronary syndrome (ACS) in the preceding 3 months, and DVT were excluded. Non-probability convenient sampling technique was used for patient inductment. The sample size was not calculated and all adult patients admitted to the hospital in the study period and fulfilling the inclusion criteria were included

After written informed consent from all the participants, detailed history was obtained before the participants underwent clinical assessment, electrocardiogram (ECG), conventional echocardiogram, and speckle tracking echocardiogram (S5-1, Philips EPIQ 7c). The assessments were done at baseline and after two weeks of the last vaccine dose.

EF, peak early diastolic velocity (E wave), peak late diastolic velocity (A wave, atrial filling), calculation of the E/A ratio, tricuspid regurge (TR) velocity, left atrium volume index (LAVI) and pulmonary artery systolic pressure (PASP) were noted. Apical 4, apical 3 and apical 2 strain values were obtained and their mean was calculated to get the global longitudinal strain (GLS).

Data was analysed using SPSS 20. Qualitative and quantitative variables were represented as means and standard deviations (SD), and as frequencies and percentages, respectively. Chi-square test, paired t-test and analysis of variance (ANOVA) were used as appropriate. P<0.05 was considered statistically significant.

Results

Of the 100 subjects, 50(50%) each were males and females. The overall mean age was 39.20±14.57 years. There were 16(16%) subjects with diabetes mellitus (DM) and 21(21%) with hypertension (HTN). Regarding vaccine distribution, 34(34%) had received AZD1222, 31(31%) had BNT162B2 and 35(35%) had BBIBP-CorV (Figure).

There was no significant difference between baseline and post-vaccine values regarding EF, S wave velocity, E wave velocity, A wave velocity, E/A ratio, mean é velocity, mean E/é, TR systolic jet velocity, LAVI, PASP, apical 4, apical 3 and

Table-1: Comparison between baseline and post-vaccination echocardiography parameters (n=100).

	Pre-vaccine	Post-vaccine	Paired t	*p-value*
PASP (mmHg)	29.36±9.41	30.12±10.16	0.987	0.315
TR Velocity (m/s)	2.41±0.52	2.45±0.50	0.754	0.512
EF (%)	67.25±3.19	67.24±3.44	0.028	0.962
S wave (cm/s)	9.59±0.91	9.39±0.87	1.912	0.052
E velocity (cm/s)	87.05±22.25	87.38±22.71	0.303	0.741
A velocity (cm/s)	77.26±12.63	76.02±12.26	1.203	0.228
E/A ratio	1.15±0.30	1.17±0.31	0.574	0.551
Mean e′ (cm/s)	13.17±4.97	13.33±4.52	0.385	0.712
E/e′	7.48±2.62	7.43±2.65	0.155	0.812
LAVI (ml/m^2)	25.83±7.66	25.71±8.24	0.119	0.901
(A4-C) LS (%)	-21.07±2.06	-20.78±2.9	1.241	0.141
(A3-C) LS (%)	-20.14±1.97	-20.41±3.14	1.485	0.102
(A2-C) LS (%)	-21.44±2.38	-20.35±3.69	1.758	0.069
GLS (%)	-20.88±1.59	-20.38±4.12	1.831	0.063

PASP: Pulmonary artery systolic pressure, TR: Tricuspid regurge, EF: Ejection fraction, LAVI: Left atrium volume index, A4-C: Apical 4 chamber, A3-C: Apical 3 chamber, A2-C: Apical 2 chamber, LS: Longitudinal strain, GLS: Global longitudinal strain.

Table-2: Comparison of vaccines regarding echocardiography parameters (n=100)

		n	Mean±SD	F	*p-value*
PASP (mmHg)	AZD1222	34	27.8906 ± 9.55790	1.948	0.148
	BBIBP-CorV	35	29.9029±9.47390		
	BNT162B2	31	32.8116±11.21867		
TR velocity (m/s)	AZD1222	34	2.3441±.48442	1.805	0.170
	BBIBP-CorV	35	2.4514±.47177		
	BNT162B2	31	2.5806±.55041		
EF (%)	AZD1222	34	67.2059±3.54007	0.307	0.737
	BBIBP-CorV	35	67.5714±3.60788		
	BNT162B2	31	66.9032±3.23888		
S wave (cm/s)	AZD1222	34	9.4294±.83395	1.206	0.304
	BBIBP-CorV	35	9.5120±.67692		
	BNT162B2	31	9.2226±.80445		
E velocity (cm/s)	AZD1222	34	90.3912±20.42959	0.781	0.461
	BBIBP-CorV	35	87.9771±22.44613		
	BNT162B2	31	83.4097±25.40847		
A velocity (cm/s)	AZD1222	34	77.6541±10.55411	2.612	0.078
	BBIBP-CorV	35	76.8652±11.56536		
	BNT162B2	31	79.2396±12.87483		

Continued on next page

Table-2: *continued from previous page*

		n	Mean±SD	F	*p-value*
E/A ratio	AZD1222	34	1.1811±0.28745	2.336	0.095
	BBIBP-CorV	35	1.1796±0.29874		
	BNT162B2	31	1.1596±0.37845		
Mean e'	AZD1222	34	13.5559±4.45663	2.423	0.092
	BBIBP-CorV	35	13.3829±4.87451		
	BNT162B2	31	12.9984±4.25413		
E/e'	AZD1222	34	7.2437±2.56321	1.984	0.187
	BBIBP-CorV	35	7.4269±2.84123		
	BNT162B2	31	7.7024±2.95843		
LAVI (ml /m^2)	AZD1222	34	24.8235±7.14979	2.694	0.073
	BBIBP-CorV	35	24.1143±7.61875		
	BNT162B2	31	28.4839±9.52145		
(A4-C) LS (%)	AZD1222	34	-20.7676±1.80063	2.928	0.057
	BBIBP-CorV	35	-21.2029±2.22201		
	BNT162B2	31	-20.6419±1.81912		
(A3-C) LS (%)	AZD1222	34	-19.6662±2.87490	2.894	0.059
	BBIBP-CorV	35	-18.9229±2.73370		
	BNT162B2	31	-19.5290±2.23132		
(A2-C) LS (%)	AZD1222	34	-19.7059±2.04835	1.622	0.203
	BBIBP-CorV	35	-20.6129±2.65090		
	BNT162B2	31	-19.7774±2.18506		
GLS (%)	AZD1222	34	-19.9721±1.37024	0.540	0.584
	BBIBP-CorV	35	-20.2690±1.48015		
	BNT162B2	31	-19.9495±1.38841		

PASP: Pulmonary artery systolic pressure, TR: Tricuspid regurge, EF: Ejection fraction, LAVI: Left atrium volume index, A4-C: Apical 4 chamber, A3-C: Apical 3 chamber, A2-C: Apical 2 chamber, LS: Longitudinal strain, GLS: Global longitudinal strain, AZD1222: AstraZeneca vaccine, BNT162B2: BioNTech Pfizer vaccine, BBIBP-CorV: Sinopharm Beijing Institute of Biological Products vaccine.

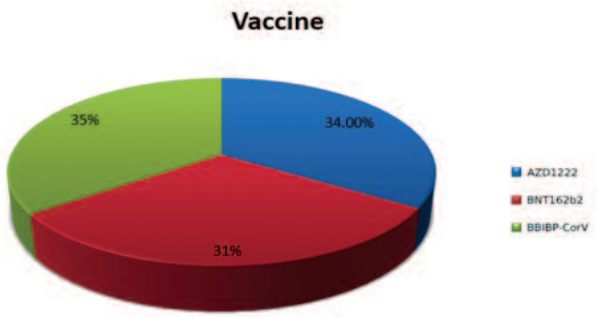

Figure: Vaccine types among the participants.
AZD1222: AstraZeneca vaccine, BNT162B2: BioNTech Pfizer vaccine, BBIBP-CorV: Sinopharm Beijing Institute of Biological Products vaccine.

apical 2 (Table 1). The mean GLS was 20.88±1.59 at baseline and 20.38±4.12 post-vaccine (p<0.063).

Also, there were no significant variations regarding echocardiography and speckle tracking distribution among different types of vaccines (Table 2).

Discussion

Despite the availability of several COVID-19 vaccines, general hesitancy in the wake of case reports of myocarditis remained an obstacle to mass uptake.[22]

A 2021 study[23] found that receiving the BNT162B2 vaccine increased the risk of myocarditis (risk ratio: 3.24; 95% confidence interval [CI], 1.55-12.44; risk difference: 2.7 cases per 100,000; 95% CI, 1.0-4.6).[23]

GLS can predict myocardial dysfunction, as it changes before LV EF.[24] Epicardial GLS changes were the same as that of late gadolinium enhancement (LGE) in cardiac magnetic resonance (CMR), the typical myocarditis pattern. Epicardial GLS changes could be used to detect myocarditis before CMR or biopsy.[24] GLS was primarily used in the current study to assess LV function.

A descriptive study[25] of 40 myocarditis case reports discovered that 90% of the cases were found in men aged 29.13+/-14.39 years. BNT162b2 vaccine was given to 65% of them, mRNA-1273 vaccine to 30%, and JNJ-78436735 vaccine to 5%. In 80% of them, myocarditis was found after the second dose.[25]

In the current study, the participants' age ranged from 17 to 72 years, with a mean of 39.20±14.57 years. Besides, 50% of the sample was male. There was no significant difference in terms of GLS at baseline and post-vaccine, and the type of vaccine also cause no significant difference in GLS terms.

However, the small sample size of the study is a limitation because of which the findings cannot be generalised. Also, the sample size was not calculated, which could have influenced the power of the study. Further studies with long-term monitoring are required to fully understand the relationship between COVID-19 immunisation and myocarditis.

Conclusion

COVID-19 vaccines studied had similarly acceptable safety profiles regarding LV functions.

Limitations. The sample size was not calculated for the study which can have an adverse effect on the power of the study.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Acter T, Uddin N, Das J, Akhter A, Choudhury TR, Kim S. Evolution of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as coronavirus disease 2019 (COVID-19) pandemic: A global health emergency. Sci Total Environ 2020;730:e138996. doi: 10.1016/j.scitotenv.2020.138996.
2. Baj J, Karakuła-Juchnowicz H, Teresiński G, Buszewicz G, Ciesielka M, Sitarz R, et al. COVID-19: Specific and Non-Specific Clinical Manifestations and Symptoms: The Current State of Knowledge. J Clin Med 2020;9:1753. doi: 10.3390/jcm9061753.
3. Garg RK, Paliwal VK, Gupta A. Encephalopathy in patients with COVID-19: A review. J Med Virol 2021;93:206-22. doi: 10.1002/jmv.26207
4. Du Y, Tu L, Zhu P, Mu M, Wang R, Yang P, et al. Clinical Features of 85 Fatal Cases of COVID-19 from Wuhan. A Retrospective Observational Study. Am J Respir Crit Care Med 2020;201:1372-9. doi: 10.1164/rccm.202003-0543OC.
5. Schultze A, Walker AJ, MacKenna B, Morton CE, Bhaskaran K, Brown JP, et al. Risk of COVID-19-related death among patients with chronic obstructive pulmonary disease or asthma prescribed inhaled corticosteroids: an observational cohort study using the OpenSAFELY platform. Lancet Respir Med 2020;8:1106-20. doi: 10.1016/S2213-2600(20)30415-X.
6. Chung JY, Thone MN, Kwon YJ. COVID-19 vaccines: The status and perspectives in delivery points of view. Adv Drug Deliv Rev 2021;170:1-25. doi: 10.1016/j.addr.2020.12.011.
7. Belete TM. Review on Up-to-Date Status of Candidate Vaccines for COVID-19 Disease. Infect Drug Resist 2021;14:151-61. doi: 10.2147/IDR.S288877.
8. Karpiński TM, Ożarowski M, Seremak-Mrozikiewicz A, Wolski H, Wlodkowic D. The 2020 race towards SARS-CoV-2 specific vaccines. Theranostics 2021;11:1690-702. doi: 10.7150/thno.53691.
9. El-Shitany NA, Harakeh S, Badr-Eldin SM, Bagher AM, Eid B, Almukadi H, et al. Minor to Moderate Side Effects of Pfizer-BioNTech COVID-19 Vaccine Among Saudi Residents: A Retrospective Cross-Sectional Study. Int J Gen Med 2021;14:1389-401. doi: 10.2147/IJGM.S310497.
10. Shimabukuro TT, Cole M, Su JR. Reports of Anaphylaxis After Receipt of mRNA COVID-19 Vaccines in the US-December 14, 2020-January 18, 2021. JAMA 2021;325:1101-2. doi: 10.1001/jama.2021.1967.
11. Albert E, Aurigemma G, Saucedo J, Gerson DS. Myocarditis following COVID-19 vaccination. Radiol Case Rep 2021;16:2142-5. doi: 10.1016/j.radcr.2021.05.033.
12. Marshall M, Ferguson ID, Lewis P, Jaggi P, Gagliardo C, Collins JS, et al. Symptomatic Acute Myocarditis in 7 Adolescents After Pfizer-BioNTech COVID-19 Vaccination. Pediatrics 2021;148:e2021052478. doi: 10.1542/peds.2021-052478.
13. Boivin Z, Martin J. Untimely Myocardial Infarction or COVID-19 Vaccine Side Effect. Cureus 2021;13:e13651. doi: 10.7759/cureus.13651.
14. Chatterjee S, Ojha UK, Vardhan B, Tiwari A. Myocardial infarction after COVID-19 vaccination-casual or causal? Diabetes Metab Syndr 2021;15:1055-6. doi: 10.1016/j.dsx.2021.04.006.
15. Waheed S, Bayas A, Hindi F, Rizvi Z, Espinosa PS. Neurological Complications of COVID-19: Guillain-Barre Syndrome Following Pfizer COVID-19 Vaccine. Cureus 2021;13:e13426. doi: 10.7759/cureus.13426.
16. Lospinoso K, Nichols CS, Malachowski SJ, Mochel MC, Nutan F. A case of severe cutaneous adverse reaction following administration of the Janssen Ad26.COV2.S COVID-19 vaccine. JAAD Case Rep 2021;13:134-37. doi: 10.1016/j.jdcr.2021.05.010.

    17 - Wei N, Fishman M, Wattenberg D, Gordon M, Lebwohl M. "COVID arm": A reaction to the Moderna vaccine. JAAD Case Rep 2021;10:92-5. doi: 10.1016/j.jdcr.2021.02.014..
18. See I, Su JR, Lale A, Woo EJ, Guh AY, Shimabukuro TT, et al. US Case Reports of Cerebral Venous Sinus Thrombosis With Thrombocytopenia After Ad26.COV2.S Vaccination, March 2 to April 21, 2021. JAMA 2021;325:2448-56. doi: 10.1001/jama.2021.7517.
19. Haakonsen HB, Nystedt A. Deep vein thrombosis more than two weeks after vaccination against COVID-19. Tidsskr Nor Laegeforen 2021;141:e0274. English, Norwegian. doi: 10.4045/tidsskr.21.0274.
20. Özdemir İH, Özlek B, Özen MB, Gündüz R, Bayturan Ö. Type 1 Kounis Syndrome Induced by Inactivated SARS-COV-2 Vaccine. J Emerg Med 2021;61:e71-6. doi: 10.1016/j.jemermed.2021.04.018.
21. Lebedev L, Sapojnikov M, Wechsler A, Varadi-Levi R, Zamir D, Tobar A, et al. Minimal Change Disease Following the Pfizer-BioNTech COVID-19 Vaccine. Am J Kidney Dis 2021;78:142-5. doi: 10.1053/j.ajkd.2021.03.010.
22. Amit AML, Pepito VCF , Sumpaico-Tanchancol L, DayritMM. COVID-19 vaccine brand hesitancy and other challenges to vaccination in the Philippines. Plos Glob Public Health 2022;2:e0000165. Doi: 10.1371/ journal.pgph.0000165.
23. Barda N, Dagan N, Ben-Shlomo Y, Kepten E, Waxman J, Ohana R, et al. Safety of the BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Setting. N Engl J Med 2021;385:1078-90. doi: 10.1056/NEJMoa2110475.
24. Kim IC, Kim H, Lee HJ, Kim JY, Kim JY. Cardiac Imaging of Acute Myocarditis Following COVID-19 mRNA Vaccination. J Korean Med Sci 2021;36:e229. doi: 10.3346/jkms.2021.36.e229.
25. Chen JH, Ikwuanusi IA, Bommu VJL, Patel V, Aujla H, Kaushik V, et al. COVID-19 Vaccine-Related Myocarditis: A Descriptive Study of 40 Case Reports. Cureus 2022;14:e21740. doi: 10.7759/cureus.21740.