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ORIGINAL ARTICLE

Clinical Predictors of Acute Myocardial Infarction Among Young Adults Beyond Covid Infection and Vaccination Era

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ABSTRACT

Background: COVID-19, a respiratory illness caused by the SARS-CoV-2 RNA virus, first appeared in Wuhan, China in December 2019 and quickly expanded worldwide. The purpose of this study was the early detection of all risk factors & clinical profile of young and very young adults with acute MI, with a trial for early prevention of acute MI in these patients, and a study complications of COVID vaccines on the cardiovascular system.

Methods: This retrospective study was conducted at the Cardiology department, Zagazig University Hospital. It involved 104 patients with acute myocardial infarction (AMI) who were divided into two groups: the very young group: 52 patients, and the Young group, 52 patients.

Result: Clinically, 86.67% of patients had chest tightness, 35.56% had palpitations, 33.33% had dyspnea, and 11.11% had chest pain. ECG readings showed 37.78% had premature atrial contractions and 28.89% had sinus tachycardia. Age and the previous revascularization by PCI negatively correlated with AMI in the overall population. Conversely, dyslipidemia and current smoking were positively associated with AMI in the overall and young CAD populations. According to the outcome, there was a statistically significant difference regarding e′, cm/s, E/e′, GCS, -%, and there was a highly statistically significant difference regarding IVSd, cm, and GLS, -% between the studied groups

Conclusion: We concluded that the clinical characteristics and variables linked to AMI following COVID-19 immunization vary across various age groups. There was a strong correlation between lifestyle variables and AMI in young individuals after receiving the COVID-19 vaccine.

Keywords: Acute myocardial infarction, young adults, post-COVID vaccination.

INTRODUCTION

COVID-19, a respiratory disease caused by the SARS-CoV-2 RNA virus, initially emerged in Wuhan, China, in December 2019 & rapidly spread around the globe. Since its inception, the virus has impacted more than 486 million people and caused over 6.1 million fatalities as of April 1, 2022. The high occurrence of COVID-19 highlights the need to promptly provide immunizations in order to prevent the COVID-19 pandemic [1].

The efficacy and safety of COVID-19 vaccines have been evaluated in randomized studies. However, these trials may not have enough statistical power to identify uncommon adverse effects. The majority of documented adverse events consisted of mild local or systemic responses, such as discomfort at the injection site, redness, swelling, fever, headache & muscle pain [2]. Nevertheless, COVID-19 vaccinations have been associated with a diverse array of negative occurrences and outcomes, such as MI, pulmonary embolism, stroke& venous thromboembolism. [3]. Although immunizations are generally successful, research on the safety of COVID-19 injections has revealed notable cardiac side effects [4]. Adverse cardiac events, like as pericarditis or myocarditis, thrombosis &

ischemia, have been associated with mRNA COVID-19 vaccines. [3]**.** The relative incidence of acute myocardial infarction (AMI) in young patients is on a continuous rise, which is explained by various factors, smoking still being the most common risk factor among young adults [5]. However, in the context of SARS-CoV-2 infection, which is responsible for 7 to 23% of myocardial lesions, this incidence tends to increase further, especially in the post-vaccination period [6], and nothing is known about whether vaccines prevent subsequent problems.

Hence, the main aim of this study was to detect early detection of all risk factors & clinical profiles of young and very young adults with acute MI with a trial for early prevention of acute MI in these patients and study complications of COVID-19 vaccines on the cardiovascular system.

Significance of the Study:

Our study aimed to fill this gap by focusing on the early detection of risk factors for AMI in young and very young adults post-COVID vaccination, with an emphasis on identifying the clinical profile of these individuals. **(5)** By exploring both the incidence of cardiovascular complications from COVID vaccines and their underlying risk factors, this study provided valuable insights into the cardiovascular safety of COVID vaccines in younger populations. More importantly, it contributed to the development of early intervention strategies to prevent AMI in this at-risk group, which had not been sufficiently addressed in prior research

.METHODS

This retrospective study was done at the Cardiology department, Zagazig University Hospital. This study was conducted on 104 people who were divided into two groups: the Young group, 52 patients, Very young group, 52 patients. The Very Young group was defined as patients aged between 18 and 32 years, and the very young group was defined as patients aged between 33 and 44 years. The exclusion of older adults allowed for a more focused examination of the unique clinical profiles and predictors in the younger population, without the confounding influence of age-related cardiovascular risk factors.

Inclusion criteria: All very young and young adult Egyptian Patients with acute myocardial infarction between 2021 and 2024.

Exclusion criteria: Patients with valvular heart disease, systemic inflammatory diseases, had known immune or connective tissue disease, known heart transplant, non-obstructive CAD. **Methods**

All patients were subjected to

Complete history taking: including age, sex, risk factors for CAD as hypertension, diabetes mellitus, smoking Status, previous history of ACS or Myocardial revascularization, dyslipidemia, and family history of premature CAD. General examination: (Blood pressure & body mass index). Local examination of the heart for cardiomegaly, pulsations, thrills, heart sounds and murmurs.

Complete Blood Count: (Assessment of Mean Platelet Volume and Platelet width, hematocrit value, homocysteine, D. Dimer).

Electrocardiographic Examination: As evidence of ischemic heart disease.

Study Procedures

We performed CBC to evaluate MPV, PDW, hematocrit, and other parameters.

We measured biochemical markers (D-dimer, uric acid, homocysteine, fibrinogen, hsCRP, HbA1c) to assess the metabolic and inflammatory profile of patients.

Coronary Angiography: (Femoral and radial approach was used for Coronary angiogram)

Femoral approach &Radial approach:

The patient was positioned supine on the examination table with arms extended or by their sides. The femoral artery and radial artery were located, and using seldenger technique , A Judkins catheter, chosen based on the anatomy, and fluoroscopic images were taken to assess the coronary arteries for blockages or abnormalities.

Ethical Consideration

A clear explanation of the study was made for all cases, and written consent was taken from each. All patient data was handled with strict confidentiality, adhering to relevant privacy

regulations and protocols. The study protocol was approved by the ethical committee and the institutional review board (IRB) of Zagazig University. IRB#: 581/27-Aug-2024. Confidentiality of data: Only the patient's initials were recorded, and if the patient's name appears on any other document, it must be kept private by the investigator. The investigator maintained a personal. Patient identification list (patient initials with the corresponding patient names to enable records to be identified).

Statistical analysis

We represented continuous data as the average ± standard deviation (SD) and categorical variables as percentages. The chi-square test was used to compare the categorical variables, whereas the independent sample t-test was utilized for analyzing the continuous variables.

We depended on the linear regression analysis method to evaluate the univariate relations.

RESULTS

This table shows that there was no statistically significant difference regarding Hospital stay length, while there was a statistically significant difference regarding age, sex, AMI, STEMI, and NSTEMI between the studied groups **(Table 1).** According to risk factors, there was no statistically significant difference regarding dyslipidemia, Current smoking, Previous PCI, Previous CABG, Psychosocial factors, drug addiction, and Testosterone replacement therapy, while there was a statistically significant difference regarding hypertension, diabetes, obesity, and Family history between the studied groups **(Table 2)**. According to clinical characteristics, there was no statistically significant difference regarding HbA1c, % & Infarcted artery, while there was a statistically significant difference regarding LVEF, %, HCY, µmol/L, MVD, n (%), Treatment of AMI and revascularization between the studied groups **(Table 3)**. According to the Vaccination profile, there was no statistically significant difference concerning dosage, list of vaccines & period from the last vaccination (day) between the studied groups (**Table 4)**. The mean age of vaccinated and developed AMI group was 38.1±4.53 years, 91.11% of patients were males, and the others were females, 75.56% of patients were smokers, 84.44% had dyslipidemia, and **13.33%** had Previous PCI.. According to clinical symptoms, 86.67% of patients had chest tightness, 35.56% of patients had palpitations, 33.33% of patients had dyspnea, and 11.11% of patients had chest pain. Regarding ECG readings, 37.78% of patients had premature atrial contractions and 28.89% of patients had sinus tachycardia **(Table 5).** Regression analysis proved that age negatively correlated with AMI in the overall population. Conversely, dyslipidemia and current smoking were positively associated with AMI in the overall and young CAD populations. Surprisingly, the previous revascularization by PCI was negatively associated with AMI in all populations **(Table 6).** According to outcome, there was no statistically significant difference regarding Follow up while there was statistically significant difference regarding e′, cm/s, E/e′, GCS, -% and there was highly statistically significant difference regarding IVSd, cm and GLS, -% between studied groups **(Table 7).**

Table 1: Dissemination of demographic data within the groups under study.

	Very young group N=52	**Young group N=52**	**P value**
Age			
Mean ± SD	**31.12±2.96**	**42.16±3.51**	**≤0.001***
Range	**18 – 32**	**33 - 44**	
Sex			

	Very young group N=52	Young group N=52	P value
Male	**50 (96.15%)**	**44 (84.61%)**	**0.04***
Female	**2 (3.84%)**	**8 (15.38%)**	
Hospital staylength, days Mean ± SD	**6.12±5.30**	**6.33±5.61**	**0.84**
Type of CAD			
AMI, n (%)	**26 (50%)**	**16 (30.76%)**	**0.04***
STEMI, n (%)	**21 (40.38%)**	**11 (21.15%)**	**0.04***
NSTEMI, n (%)	**8 (15.38%)**	**2 (3.84%)**	**0.03***

AMI, acute myocardial infarction, STEMI, ST-elevation myocardial infarction, NSTEMI, NSTEMI: non-ST-elevation myocardial infarction

Table 2: distribution of risk factors among studied groups.

	Very young group N=52	Young group N=52	P value
Hypertension, n (%)	**17 (32.69%)**	**27 (51.92%)**	**0.04***
Diabetes, n (%)	**7 (13.46%)**	**12 (23.07%)**	**0.02***
Dyslipidemia, n (%)	**43 (82.69%)**	**40 (76.92%)**	**0.4**
Current smoking, n (%)	**34 (65.38%)**	**31 (59.61%)**	**0.54**
Obesity, n (%)	**17 (32.69%)**	**8 (15.38%)**	**0.03***
Previous PCI, n (%)	**7 (13.46%)**	**9 (17.30%)**	**0.58**
Previous CABG, n (%)	**0 (0.00%)**	**2 (3.84%)**	**0.15**
Family history, n (%)	**9 (17.30%)**	**17 (32.69%)**	**0.04***
Psychosocial factors, n (%)	**3 (5.76%)**	**5 (9.61%)**	**0.46**
Drug addiction, n (%)	**2 (3.84%)**	**4 (7.69%)**	**0.4**
Testerone replacement therapy, n (%)	**4 (7.69%)**	**5 (9.61%)**	**0.72**

Table 3: distribution of clinical characteristics among studied groups.

	Very young group N=52	Young group N=52	P value
LVEF, % Mean ± SD	**58.97±9.12**	**61.00±9.15**	**0.01***
HCY, µmol/L Mean ± SD	**21.01±14.11**	**17.03±10.99**	**0.02***
HbA1c, % Mean ± SD	**6.00±1.41**	**6.12±1.32**	**0.6**
Infarcted artery			
LM, n (%)	**4 (7.69%)**	**2 (3.84%)**	**0.4**
LAD, n (%)	**32 (61.53%)**	**36 (69.23%)**	**0.41**

LCX, n (%)	**17 (32.69%)**	**20 (38.46%)**	**0.53**
RCA, n (%)	**19 (36.53%)**	**23 (44.23%)**	**0.43**
MVD, n (%)	**21 (40.38%)**	**29 (55.76%)**	**0.01***
Treatment of AMI			
PCI, n (%)	**35 (67.30%)**	**34 (65.38%)**	**0.03***
CABG, n (%)	**3 (5.76%)**	**11 (21.15%)**	
conservative, n (%)	**14 (26.92%)**	**7 (13.46%)**	
Revascularization, n (%)	**35 (67.30%)**	**45 (86.53%)**	**0.03***

HCY, homocysteine; LAD, left anterior descending; LCX, left circumflex; LM, left main; LVEF, left ventricular ejection fraction; MVD, multivessel disease; CABG, coronary artery bypass grafting

Table 4: distribution of Vaccination profile among studied groups.

	vaccinated and developed AMI (case) group N=45	**vaccinated and not developed AMI (control) group N=59**	**P value**
Dosage			
first dosage	**45 (100%)**	**59 (100%)**	**1**
second booster doses	**24 (53.33%)**	**30 (50.85%)**	**0.8**
third booster doses	**5 (11.11%)**	**3 (5.08%)**	**0.25**
list of vaccines			
AstraZeneca	**30 (40.54%)**	**38 (41.30%)**	**0.87**
Moderna	**29 (39.18%)**	**35 (38.04%)**	
BioNTech (Pfizer)	**13 (17.56%)**	**18 (19.56%)**	
Medigen	**2 (2.70%)**	**1 (1.69%)**	
Total	**74 (100%)**	**92 (100%)**	
number of vaccine doses administered 166			
period from the last vaccination, days	**28 ± 6.11**	**30 ± 5**	**0.06**

Table 5: distribution of demographic data, risk factors and clinical symptoms after vaccination.

	vaccinated and developed AMI group N=45
Age	
Mean ±SD	**38.1±4.53**
21-27 years	**15 (33.33%)**
28-32 years	**13 (28.89 %)**
33 -38 years	**10 (22.22 %)**

39-44 years	**7 (15.56%)**
clinical symptoms	
chest tightness	**39 (86.67%)**
palpitations	**16 (35.56%)**
dyspnea	**15 (33.33%)**
chest pain	**5 (11.11%)**
Sex	
Male	**41 (91.11%)**
Female	**4 (8.89%)**
Smoking	**34 (75.56%)**
Dyslipidemia	**38 (84.44%)**
Previous PCI	**6 (13.33%)**
ECG readings	
premature atrial contractions	**17 (37.78%)**
sinus tachycardia	**13 (28.89%)**

Table 6: Independent risk factors of acute myocardial infarction after vaccinations.

Variables	**Overall**			**Very young group**			**Young group**		
	HR	**95% CI**	**P value**	**HR**	**95% CI**	**P value**	**HR**	**95% CI**	**P value**
Age	**0.897**	**0.721–0.950**	**0.007**						
Previous PCI	**0.533**	**0.320–0.575**	**<0.001**	**0.277**	**0.130–0.592**	**0.002**	**0.473**	**0.345–0.621**	**<0.001**
Dyslipidemia	**1.552**	**1.192–2.210**	**0.003**				**1.876**	**1.281–2.541**	**0.003**
Current smoking	**1.523**	**1.189–1.950**	**<0.001**				**1.569**	**1.191–2.010**	**0.001**

Table 7: distribution of outcome among studied groups.

	vaccinated and developed AMI (case) group N=45	**vaccinated and not developed AMI (control) group N=59**	**P value**
Echocardiographic examination			
IVSd, cm Mean ± SD	**0.95 ± 0.26**	**0.79 ± 0.24**	**0.001**
e′, cm/s Mean ± SD	**8.59 ± 4.02**	**10.34 ± 3.49**	**0.019**
E/e′ Mean ± SD	**9.41 ± 3.60**	**7.69 ± 2.45**	**0.004**
Myocardial strain analysis			
GLS, -%	**18.01 ± 3.11**	**19.89 ± 2.14**	**0.0004**

Mean ± SD			
GCS, -% Mean ± SD	**18.00 ± 5.73**	**20.62 ± 4.04**	**0.007**
Follow up			
Discharged, n (%)	**42 (93.33%)**	**58 (98.30%)**	**0.19**
Died, n (%)	**3 (6.67%)**	**1 (1.69%)**	

IVSd: interventricular septal width in diastole *E vel* early mitral flow velocity *e'* early diastolic mitral annular velocity *GLS* global longitudinal strain GCS, global circumferential strain.

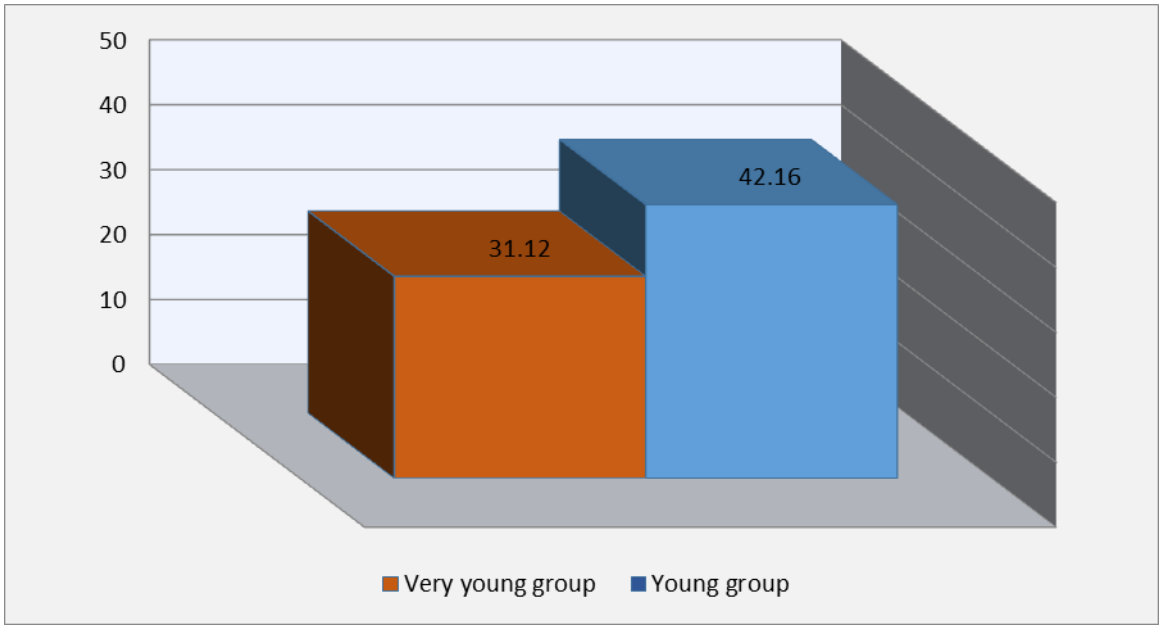

Fig 1: shows age distributions among studied groups.

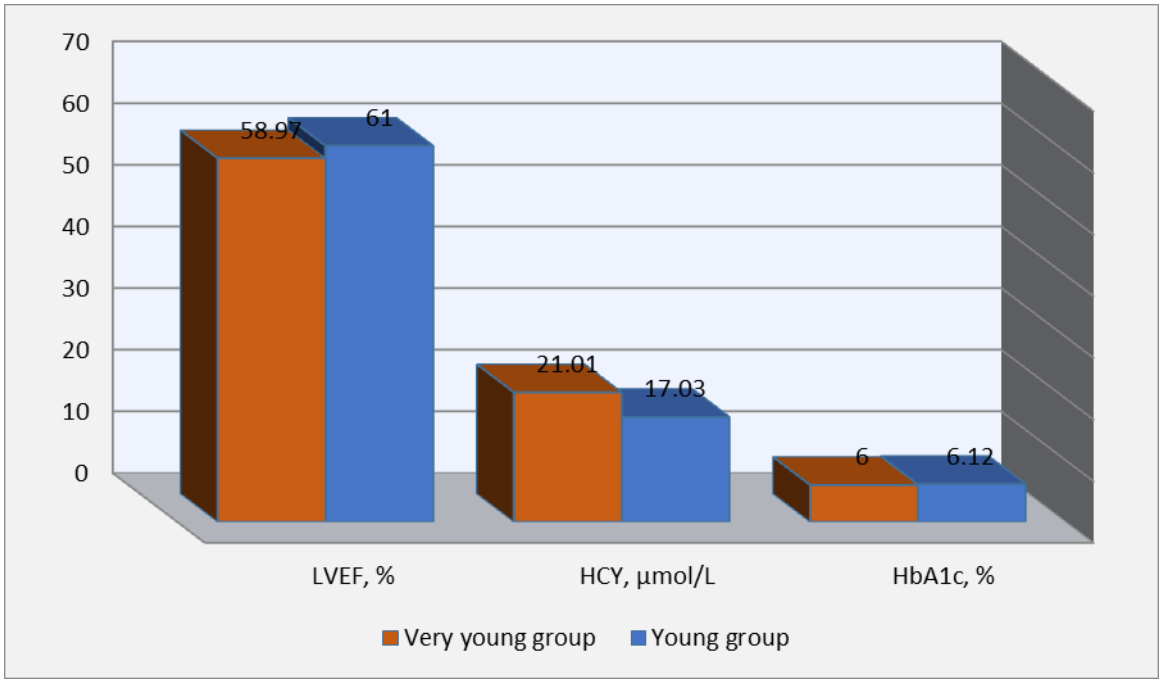

Fig 2: shows clinical investigations among studied groups.

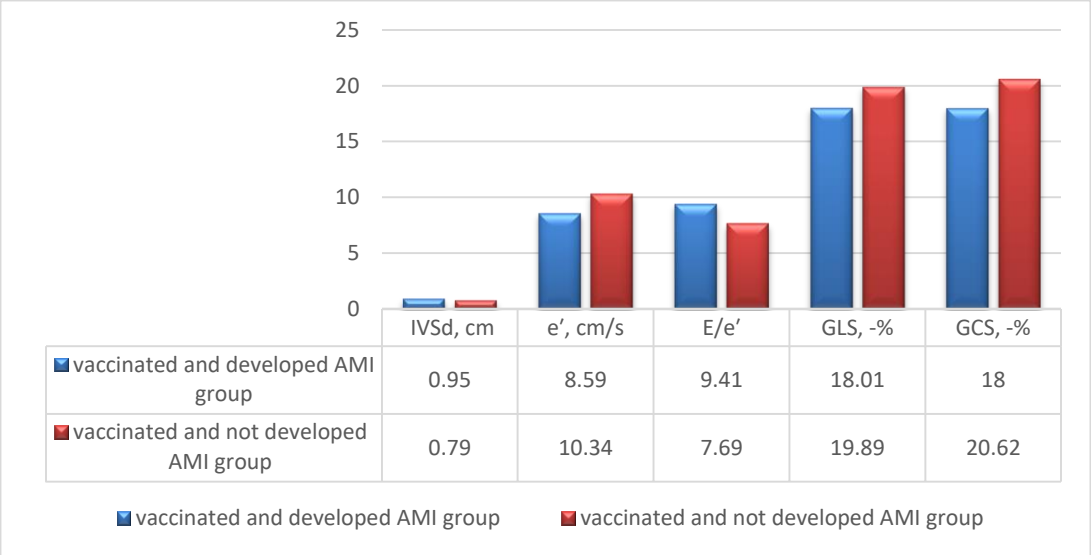

Fig 3: shows Echocardiographic examination and myocardial strain analysis among studied groups.

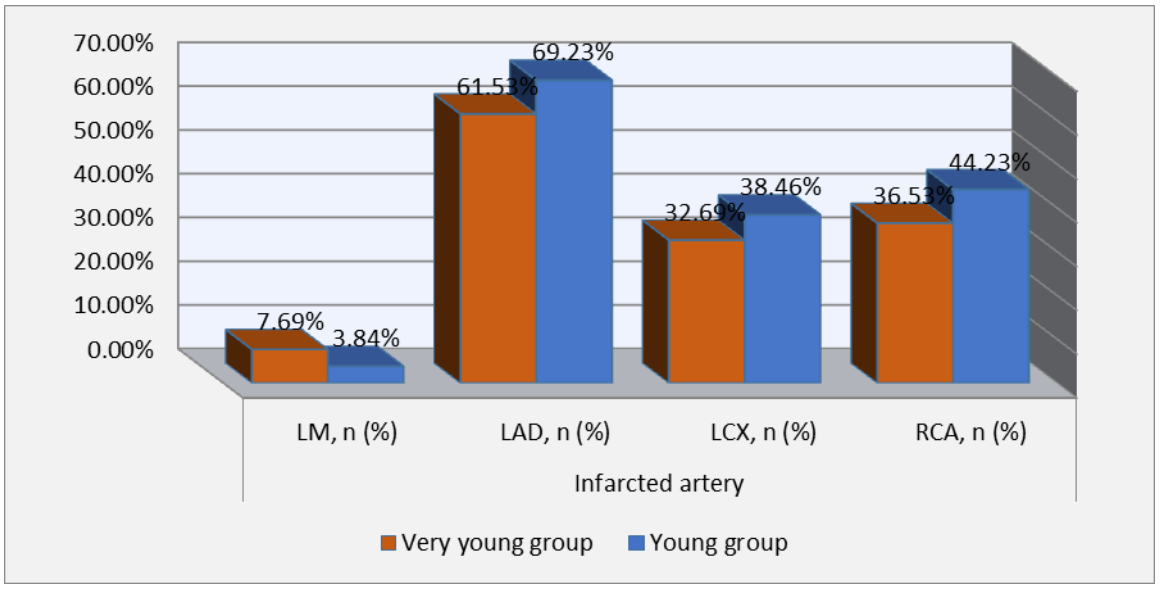

Fig 4: shows Infarcted artery among studied groups.

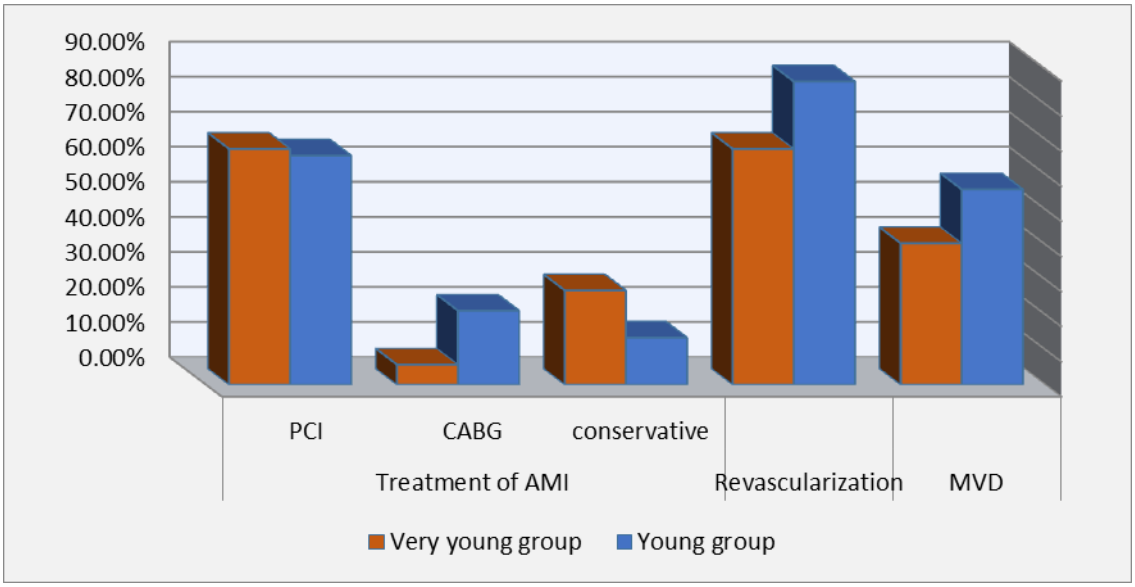

Fig 5: shows Treatment of AMI and Revascularization among studied groups.

DISCUSSION

Following a COVID-19 infection, there is an elevated susceptibility to thrombosis, which has been associated with a greater occurrence of AMI and ischemic stroke after the infection. **[5-**[8] SARS-CoV-2 vaccines work against COVID-19 and its severe sickness. However, nothing is known about whether vaccines prevent subsequent problems. [9]

Hence, this study investigated the early detection of all risk factors & clinical profile of young and very young adults with acute MI with trial for early prevention of acute MI in these patients and studied complications of COVID-19 vaccines on the cardiovascular system.

The scientific evidence linking COVID-19 immunization to MI is inadequate. The immunization may increase the heart rate, but it does not cause MI. [10]**.** It is not a commonly documented relationship that MI occurs after receiving the COVID-19 vaccine. **Boivin et al.** [11] documented a case of a 96-year-old lady in the United States who experienced a myocardial infarction (MI) one hour after receiving her initial dosage of the Moderna COVID-19 vaccination.

Chatterjee et al. [12] provided a comprehensive account of a 63-year-old guy who, although not having any previous symptoms associated with coronary artery disease, suffered a sudden ST-elevated inferior wall myocardial infarction (MI) two days after receiving the Covishield COVID-19 vaccination. The occurrence of pain at the injection site may lead to the manifestation of ischemia symptoms, which can delay the start of symptoms, making the early detection of this severe cardiovascular condition difficult [13]**.**

Regarding demographic data, our results showed that there was no statistically significant difference regarding hospital stay length, while there was a statistically significant difference regarding age, sex, AMI, STEMI, and NSTEMI between the studied groups.

Our findings also supported **Zhang et al.'s** study of young and extremely young CAD patients to discover age-related risk factors for AMI [14]**.** They showed that the groups were significantly different in terms of age, sex, AMI, STEMI, and NSTEMI. It should be noted that the frequencies of AMI (49.0 vs. 31.8%), STEMI (37.0 vs. 24.1%), and NSTEMI (11.9 vs. 7.7%), were greater in extremely young patients.

We found no statistically significant difference among the groups when it came to dyslipidemia, current smoking, previous PCI, previous CABG, psychosocial factors, drug addiction, or testosterone replacement therapy, but there was a significant difference when it came to hypertension, diabetes,

obesity, and family history. Similarly, **Zhang et al.** [14] found that older individuals had much greater incidences of hypertension and diabetes.

As regards clinical characteristics, our results showed that there was no statistically significant difference regarding HbA1c % & Infarcted artery while there was statistically significant difference regarding LVEF, homocysteine (HCY), multivessel disease (MVD), Treatment of AMI and revascularization between studied groups.

All age groups, including youth, middle age, and old age, are at increased risk for atherosclerotic disease when hyperhomocysteinemia is present. [15] A higher risk of MI and stroke and worsening vascular disease, is linked to elevated homocysteine levels [16]**,** [17]**.**

Following correction for conventional confounders, a new research included 1,103 young adults (aged 18–35) identified hyperhomocysteinemia to be an independent predictor of acute coronary syndrome (ACS) [18]**.** Additionally, there was an increase in the frequency of STEMI, MVD, and lower LVEF in young ACS patients with hyperhomocysteinemia.

Also, **Zhang et al.,** [14] demonstrated that In terms of left ventricular ejection fraction (LVEF), homocysteine (HCY) & multivessel disease (MVD), the groups that were compared showed statistically significant differences. Younger individuals had much higher HbA1c values.

According to Vaccination profile, this study reported that there was no statistically significant difference concerning dosage, list of vaccines & period from the last vaccination (day) between studied groups.

Regression analysis proved that age negatively correlated with AMI in the overall population. Conversely, dyslipidemia and current smoking were positively associated with AMI in the overall and young CAD populations. Surprisingly, the previous revascularization by PCI was negatively associated with AMI in all populations**.** According to outcome, there was no statistically significant difference regarding Follow up (discharged or died) while e′, cm/s, E/e′, GCS, -% , IVSd, cm and GLS, -% were significantly lower in vaccinated and developed AMI group.

Findings from this study corroborated those of **Chaichuum et al.,** [19] who investigated the function of myocardial strains in the preliminary evaluation of clinical manifestations following COVID-19 immunization. In diastole, individuals with symptoms showed a wider interventricular septal width (IVSd) compared to those without symptoms in the control group (p=0.002). In comparison to the normal group, individuals experiencing symptoms exhibited a higher ratio of the early filling mitral annular velocity (eˠ) to the early diastolic mitral annular velocity (E/e′). In order to measure GLS and GCS, 66 vaccinated patients who experienced cardiac AEs were examined for myocardial deformation. The control group consisted of 55 vaccinated patients. When comparing the case group to the control group, the GLS was much lower in the former. Similarly, compared to the control group, individuals who had heart pain had a much lower GCS (p=0.028). The findings proved that Global Longitudinal Strain and Global Circumferential Strain may detect myocardial dysfunction before it is clinically noticeable. Also, the study conducted by **Holzknecht et al., [20]** demonstrated that GLS emerged as an independent predictor of MACE after adjustment for parameters of LV function and myocardial damage as well as angiographic and clinical characteristics, with superior prognostic validity compared to LVEF.

Limitations

This study was limited by small sample size, lack of control group and the retrospective nature of the study may have resulted in bias. Second, the follow-up information was not available. Therefore, further large-scale studies are needed to confirm our findings

CONCLUSIONS

Vaccine research and development has emerged as the sole viable strategy for dealing with the epidemic, as stated by the World Health Organization. Vaccines are worth the

risk of any side effects since they prevent disease. The potential cardiac side effects of the COVID-19 vaccine were still focus of this investigation. We proved that cardiac strain analysis using tissue speckle tracking was a beneficial, non-invasive, and cost-effective method. As a result of our research, GLS and GCS have the potential to be useful indicators for assessing cardiac abnormalities in COVID-19 vaccine symptoms. We found that there are age-related differences in the clinical profiles and risk variables for AMI following COVID immunization. In young patients after COVID-19 immunization, lifestyle variables were substantially linked to AMI. This study suggests careful observation of symptoms and prompt treatment of complications to decrease mortality. Also, our findings highlight the need to use more aggressive preventive strategies targeting lifestyle and risk factor modification even earlier in life.

Conflicts of Interest

The authors report no conflicts of interest.

Funding Information

None declared

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