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Impact of the COVID-19 Pandemic on STEMI Presentation and Clinical Outcomes: A Single-Center Experience from Tripoli, Libya

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ABSTRACT

The COVID-19 pandemic disrupted healthcare systems worldwide, potentially overshadowing other medical emergencies, including ST-elevation myocardial infarction (STEMI).

This single-center observational study aims to assess changes in STEMI incidence, clinical presentation, risk factors, and the timing of presentation (from symptom onset to first medical contact [FMC]). Additionally, it evaluates treatment guidelines and in-hospital events between the pre-COVID-19 and post-COVID-19 periods. Acute STEMI cases were retrospectively identified at the National Heart Center in Tripoli. The post-COVID-19 period (April 1, 2020, to December 31, 2021) was compared to the pre-COVID-19 period (January 1, 2019, to March 31, 2020).

A total of 124 patients were enrolled: 76.6% were male, and 23.4% were female. Over half of the participants (52.4%) were under age 60. This younger demographic was more prevalent in the post-COVID-19 period compared to the pre-COVID-19 period (60.6% vs. 43.1%; *P*=.07), which contrasts with the common association of STEMI with older age. Regarding the time from symptom onset to FMC, only 36.2% of patients arrived after 12 hours in the pre-COVID-19 period, whereas 54.5% faced similar delays post-COVID-19 a statistically significant increase (*P*=.02).

Conclusion: While there was a significant delay in seeking medical contact, admission trends, clinical parameters, risk factors, and mortality rates showed no significant differences between the two periods. Our data suggests that the standard of care for STEMI was maintained during the pandemic, resulting in non-significant changes in patient outcomes.

***Keywords**: STEMI Treatment guideline; COVID-19 Pandemic; Patient delay; Epidemiological shift; Time delay.*

INTRODUCTION

ST-segment elevation myocardial infarction (STEMI) remains a major cause of cardiovascular mortality and morbidity worldwide. Clinically, patients typically present with pathological ST-segment changes on an ECG and persistent chest pain often lasting more than 15 minutes that radiates to the shoulder, left arm, back, or jaw. This primary symptom is frequently accompanied by systemic distress, including nausea, vomiting, diaphoresis, dyspnea, anxiety, syncope, and palpitations.[1] It is a severe form of acute coronary syndrome characterized by a complete blockage of a coronary artery, leading to myocardial necrosis.[2] That is why STEMI is a fatal disease usually diagnosed in emergency units, and restoring blood flow quickly is so important to keep the damage from being permanent or at least minimizing the severity of the damage.

The risk factors for STEMI are classified as non-modifiable risk factors including age and gender, and modifiable risk factors such as smoking, hypertension (HTN), diabetes mellitus (DM), abnormal lipid profile and history of cardiac diseases.[3] It was demonstrated that the mortality could be decreased by the modification of risk factors, most of which are potentially modifiable. Therefore, determining the prevalence of risk factors for STEMI will help to determine the priorities for protection from STEMI according to a specific risk profile and provide better primary health care for patients.[4]

The management of STEMI focuses on the rapid restoration of coronary blood flow through either pharmacological fibrinolysis (e.g., Alteplase or Tenecteplase) or non-pharmacological interventions like Percutaneous Coronary Intervention (PCI), whereas PCI mechanically relieves blockages using balloon angioplasty and stent deployment or coronary artery bypass graft surgery (CABG). The choice between these strategies is highly timesensitive and governed by the "total ischemic time." Guidelines prioritize primary PCI: it should be implemented immediately in a PCIcapable center. In settings where primary PCI cannot be performed within 120 minutes of first medical contact (FMC), fibrinolytic therapy should be considered; if fibrinolysis fails, rescue PCI should be considered. Therefore, the clinical goal is to minimize delays from FMC to diagnosis to under 10 minutes, ensuring the most effective reperfusion strategy is deployed based on the hospital's capabilities and the patient's symptom onset.[5]

However, the National Heart Center has adopted a strategy of giving fibrinolytic therapy to patients presenting within the first 12 hours of symptom onset, while performing

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primary PCI for patients who present later or for those with contraindications to fibrinolysis, due to resource utilization and the risk of viral exposure for healthcare providers.

The global COVID-19 pandemic, caused by the SARS-CoV-2 virus, has profoundly impacted healthcare delivery, raising concerns about its effect on the management of time-sensitive conditions like STEMI.[6] Reports from various regions have indicated a decline in STEMI admissions during the pandemic around the world.[7] The reasons for these phenomena are unclear. One explanation for the decrease includes patients are staying home due to fear of being infected by the coronavirus and other patients presenting late in their STEMI course due to the same concerns, especially in case of atypical or mild STEMI clinical presentation. Other hypothetical reasons are, better adherence to treatment, limited physical activity or absence of occupational stress during lockdown.[8] Conversely, COVID-19 infection itself has been associated with an increased risk of cardiovascular events, including myocardial infarction, through mechanisms such as systemic inflammation, hypercoagulability, and direct myocardial injury.[9] This raises questions about the impact of this pandemic on health care system in general and particularly the coronary care unit (CCU). Therefore, this study aims to compare the incidence, clinical characteristics, and management strategies of STEMI at the National Heart Centre in Tripoli, Libya, during the pre- and post-COVID-19 periods. It evaluates the pandemic's impact on symptom-to-reperfusion intervals, adherence to treatment guidelines, clinical outcomes, and hospital length of stay, identifying shifts in acute cardiovascular care quality during the health crisis.

MATERIALS AND METHODS

A retrospective observational study included all consecutive patients over 18 years of age admitted with a diagnosis of acute STEMI to the coronary care unit of the National Heart Center in Tripoli between January 1, 2019, and December 31, 2021. The study population was divided into two groups: a pre-COVID-19 group (admissions from January 1, 2019, to March 31, 2020) and a post-COVID-19 group (admissions from April 1, 2020, to December 31, 2021). Data were collected from patient medical records using a predesigned form, capturing demographic information, clinical presentation, risk factors, onset of pain, treatment strategies (thrombolysed or non-thrombolysed), complications of therapy and in-hospital outcomes. Statistical analysis was performed using SPSS version 26. Categorical variables were compared using the Chi-squared or Fisher's exact tests, and numerical data were compared using the Mann-Whitney U test. A *P*-value of <0.05 was considered statistically significant.

RESULTS

A total of 124 STEMI patients admitted to the Coronary Care Unit (CCU) at the National Heart Center were enrolled in this study, with 58 in the pre-COVID-19 period and 66 in the post-COVID-19 period.

Demographic Characteristics and Admission Trends

Gender distribution revealed a male predominance within the total study population (76.6%). Although the proportion of male admissions was higher during the post-COVID-19 period compared to the pre-COVID-19 period, 81.8% vs. 70.7%, respectively (**Figure 1**), this did not reach statistical significance (*P* value =.20).

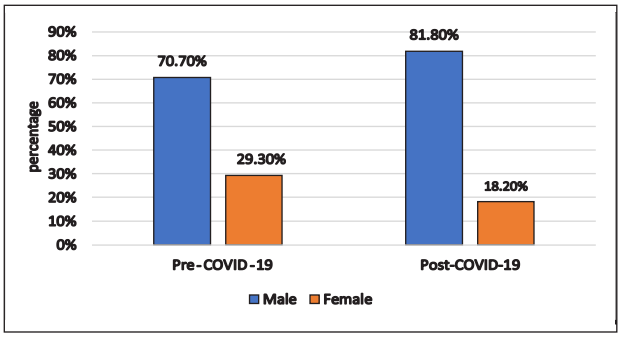

Figure 1: The percentage of patients according to gender group in the pre- and post- COVID-19 periods

The mean age of the study population was 61.1 ± 11.8 years. Age distribution (Figure 2) revealed that more than half of the participants (52.4%) were under the age of 60. When comparing the two study periods, a higher proportion of patients under 60 years old was observed during the post-COVID-19 period (60.6%) compared to the pre-COVID-19 period (43.1%). Although this suggests a trend toward younger STEMI admissions during the pandemic, the difference was not statistically significant (*P* value =.07).

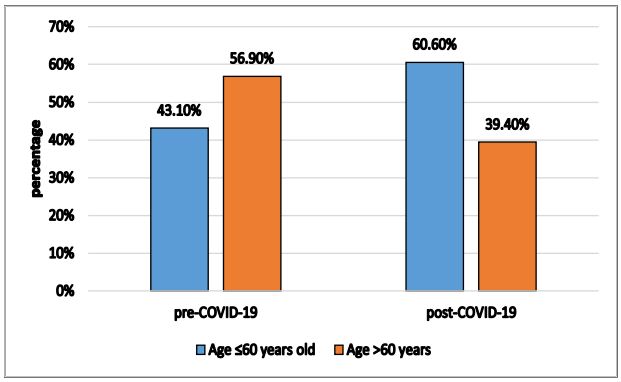

Figure *2*: The percentage of patients according to age group in the pre and post- COVID-19 periods

The study examined STEMI admission trends among 124 patients pre-COVID-19 (1 January 2019- 31 March 2020) and post-COVID 19 period (1 April 2020 - 31 December 2021), shown in Figure 3**,** with no significant difference observed (*P* value =.06).

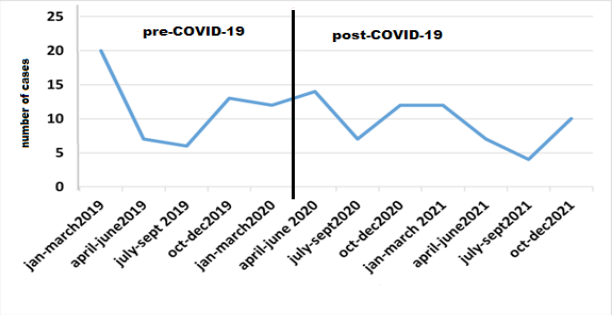

Figure 3: Admission trends of acute STEMI among 124 patients enrolled in the study between the pre-COVID-19 and post-COVID-19 periods.

Clinical presentation and type of treatment

As shown in Figure 4, regarding the time from onset of symptoms to FMC, only 36.2% of patients in the pre-COVID-19 period arrived after more than 12 hr. while 54.5% in the post-COVID-19 period arrived at the same delay time; this increase in time delay was statistically significant (*P* value =.02).

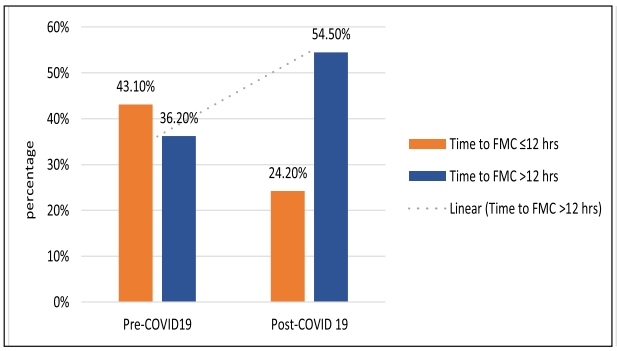

Figure 4: The percentage of patients according to the time from onset of symptoms to FMC in the pre and post-COVID-19 periods**.**

Regarding the treatment strategies as shown in Figure 5, 54 % of all patients treated with non-thrombolytic strategy of which 59.1% in the post-COVID-19 compared to 48.3% in the pre- COVID19 period. While the rest of the patients treated with thrombolytic therapy were 19.4% thrombolysed with Actylase® and 26.6% thrombolysed with Metylase® with no significant differences between the study periods.

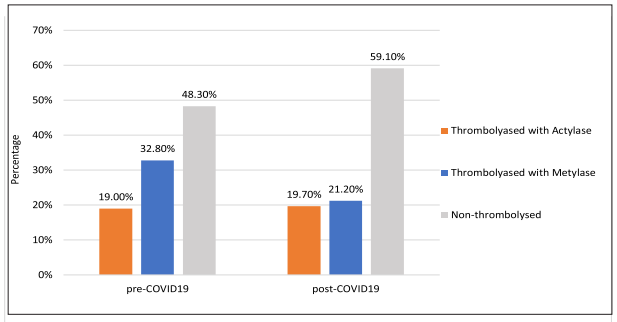

Figure 5: The percentage of patients according to treatment strategy in the pre- and post- COVID-19 periods.

Regarding patient's clinical presentations, most of patients 94.4% complain of chest pain with approximately the same proportions pre and post -COVID19 periods. However, nearly 47.6% of patients experience dyspnea with higher incidence in post -COVID-19 period compared to pre -COVID-19 period 53% and 41.4% respectively. Of total patients, 41.1% had normal systolic BP and 46.8% had normal diastolic BP with no significant differences between the two period pre and post -COVID-19. While 71.8% of patients showed a normal heart rate with no significant differences between the two periods pre and post -COVID-19 and more than half of all patients 50.8% had normal O_2 -SAT%, all of which not significantly different between the study periods.

Cardiovascular Risk Profiles and Comorbidities

Smoking was reported in 60.5% of the total patients, with no differences in the two study periods (p=0.279). Traditional cardiovascular risk factors and comorbidities, including DM 61.3%, dyslipidemia 12.1%, HTN 44.4%, history of cardiac diseases 25.8% and all of which were not statistically different across the study period**.**

Table 1: Risk factors for STEMI patients in pre- and post-COVID -19 periods

Risk factors	Pre covid19 N=58	Post covid19 N=66	Total N=124	*P* value
Hypertension	50%	39.40%	44.40%	0.279
Diabetes	56.90%	65.20%	61.30%	0.362
Dyslipidemia	6.90%	16.70%	12.10%	0.108
Smoking	60.30%	60.60%	60.50%	1
Cardiac Disease	20.70%	30.30%	25.80%	0.304

Prevalence of Pre-existing Cardiovascular Disease

As outlined in Table 2, patients' previous medical history includes 16.9% who had prior MI, 13.7% who underwent prior PCI and 0.8% who underwent prior CABG, all of which were not statistically different across the study period.

Table 2: Medical history of patients during COVID-19 pandemic (April 2020-Dec2021) and pre-COVID-19 (Jan2019-March2020)

History of	N	Pre -COVID19 N=58	Post- COVID19 N=66	Total N=124	*P* value
prior PCI	1	10.3%	16.7%	13.7%	0.434
Prior MI	1	17.2%	16.7%	16.9%	1
Prior CABG	1	0.0%	1.5%	0.8%	1

Clinical Outcomes: In-Hospital Morbidity and Mortality

As shown in Table 3, the overall mortality rate was 16.1%. This was not significantly different between the two study periods. Stroke was reported in 0.8 %, and ventricular aneurysm was reported in 11.3% of total patients. In-hospital, arrhythmias, both tachycardia and bradycardia, were reported in 7.3% and 6.5%, respectively. In addition, the length of hospital stay in days was 62.1% of patients; the remaining 37.9% stayed 8 days or more. All of which were not statistically different across the study period.

Table 3: Morbidity and mortality among STEMI patients during COVID19 pandemic (April 2020 - Dec 2021) and pre-COVID-19 (Jan 2019 - March 2020)

		N	Pre covid19 N=58	Post covid 19 N=66	Total N=124	P value
Stroke TIA		1	0.0%	1.5%	0.8%	1
Ventricular aneurysm		14	8.6%	13.6%	11.3%	0.411
Arrythmia	**Bradycardia**	8	8.6%	4.5%	6.5%	0.540
	Tachycardia	9	8.6%	6.1%	7.3%	
Hospital stays in days	**days 8>**	77	63.8%	60.6%	62.1%	0.853
	days 8≤	47	36.2%	39.4%	37.9%	
Outcomes	**Discharge**	104	86.2%	81.8%	83.9%	0.627
	Death	20	13.8%	18.2%	16.1%	

There were no significant differences in the prevalence of traditional cardiovascular risk factors, including smoking, diabetes mellitus, hypertension, and dyslipidemia, between the two periods. Similarly, the clinical presentation, including hemodynamic parameters and symptoms like chest pain and dyspnea, did not differ significantly. The treatment strategies employed, whether thrombolytic therapy or primary percutaneous coronary intervention (PCI), also showed no significant variation. Furthermore, the rates of in-hospital complications such as bleeding, arrhythmia, and mortality remained comparable between the pre- and post-COVID-19 periods.

DISCUSSION

While acute respiratory infections are historically associated with an increased risk of acute cardiovascular events, exemplified by a fivefold higher risk of myocardial infarction (MI) during influenza infections.[10] The COVID-19 pandemic introduced a paradoxical shift in clinical observations. Despite the established biological link between viral inflammation and cardiac stress, large-scale meta-analyses and regional studies, such as those conducted in Saudi Arabia and Egypt, reported a significant 24% reduction in hospitalizations for STEMI during the pandemic.[8,11,12] The biological explanation for this phenomenon seems unlikely, as COVID-19 impacts the cardiovascular system through various mechanisms, such as myocardial injury due to hemodynamic issues or hypoxemia, inflammatory myocarditis, stress cardiomyopathy, microvascular endothelial dysfunction, and coagulation cascade activation. These factors can destabilize coronary plaques, leading to acute coronary syndrome.[13]Therefore, the decrease in hospital admissions for STEMI might be complicated by external factors such as under diagnosis or patients' behaviours during the pandemic, including underestimating cardiac symptoms and fearing infection in emergencies. [11] Additionally, this trend was notable during national lockdowns, possibly due to reduced air pollution, better treatment adherence, less physical activity, or reduced occupational stress.[7,14] The STEMI admission trends observed herein showed no significant change between the pre- and post-COVID-19 periods (Figure 3), aligning with findings from recent observational studies in France and Germany.[15,16]

Many studies show that the time from symptom onset to FMC was longer during the post–COVID19 period than during the pre–COVID19 period. This delay was associated with a higher risk of in-hospital complications and reduced left ventricular function (17,18). Our study observed a significant increase in patients experiencing delays greater than 12 hours during the pandemic (54.5% post–COVID19 vs. 36.2% pre–COVID19; P = .02), consistent with other findings.[8,17,18] In the United States, similar delays were reported, with reasons including fear of COVID-19 (27%), misattributing symptoms to COVID19 (18%), and not wanting to burden hospitals (9%) (19). Research on patient delays and public awareness campaigns about coronary artery disease during the pandemic shows mixed effects, highlighting the

importance of addressing psychological and behavioral factors in targeted messaging.[12,20,21] Furthermore, recent study emphasizes that the use of Pre-hospital ECG may have provided significant advantages for patient transport time and clinical outcomes especially in urban areas.[22]

According to the consensus statement on the management of myocardial infarction during the COVID-19 pandemic, primary PCI remains the standard of care for STEMI patients at PCI-capable centers when it can be provided on time (within 120 minutes) with an expert team outfitted with personal protective equipment at specific catheterization laboratory. while fibrinolytic therapy may be used at a non-PCI-capable centre or in specific situations where primary PCI cannot be performed or is not the best option.[23] However, in the National Heart Center they adopted a strategy to give fibrinolytics to patients presenting within the first 12 hours of symptom onset, while they perform primary PCI for those who are admitted later. Regarding treatment strategies (Figure 5), we found 54% of all patients underwent PCI, with an incidence 59.1% in the post-COVID-19 period compared to 48.3% in the pre-COVID-19 period (*P*=.33). Contradicting many other studies finding a decrease in catheterization laboratory activity during the pandemic.[11,15,24] The reason for this could be the increased time delay from symptoms to FMC that we discussed before, and the adaptive management strategy in national heart center.

In this study, there were three times more male than female patients (76.6% male vs. 23.4% female), similar to findings in Egypt (78.3% male vs. 21.7% female).[11]This supports the idea that males have a higher risk of STEMI.[25] Regarding age, 52.4% of participants were under 60, with more in this group post-COVID (60.6% vs. 43.1%, *P*=0.07). This contrasts with the common view of older age as a STEMI risk factor[25,26], suggesting further research is needed.

The prevalence of hypertension, diabetes, dyslipidemia, cigarette smoking and preexisting coronary heart disease among STEMI patients was not significantly different across the study period (Table 1), and this is similar to several other studies done in different geographical regions.[8,11,15,17]

Additionally, patients' previous medical history (Table 2) includes prior MI, prior PCI and prior CABG, all of which were not statistically different across the study period, which is in line with other studies.[8,27] Contrary to other studies reporting a significant reduction of prior MI history among patients with STEMI admitted in COVID19 period. [27,28]

Regarding morbidities as shown in Table 3, ventricular aneurysm was reported in the highest percentage, 11.3% of total patients, arrhythmias, both tachycardia and bradycardia, were reported in 7.3% and 6.5% respectively, all of which were not statistically different across the study period, in line with many other studies.[8,16]While stroke was reported only in 0.8% of the total, with no statistical difference between the pre and post COVID19 period, in line with Sadia Arabia.[8] But contradicting another study conducted in Egypt, where they found a significant decrease in stroke during the pandemic from 5.5% vs 3.7%, with *P* value=0.022.[11]

While a significant body of literature reports a marked increase in the duration of hospital stays. [11,15-17] The present results align with Fardman et al. in demonstrating no statistically significant difference in length of stay across the study period.[27]This suggests a degree of institutional resilience in patient throughput despite the logistical pressures of the pandemic. However, a critical disparity was observed regarding mortality.[29] The overall mortality rate in this cohort was nearly four times higher than that reported in a similar study conducted in Saudi Arabia (16.1% vs. 4.2%), although neither study observed a significant fluctuation between the pre- and post-COVID-19 periods.[8] This elevated baseline mortality contrasts with other findings[15,17], who identified an escalation in mortality specifically linked to the pandemic era. These discrepancies likely reflect the impact of potential delays in hospital referrals and the varying degrees of patient "avoidance behavior" across different healthcare systems, highlighting that while the pandemic's impact on hospital logistics was variable, the clinical severity of presenting cases remained high.

CONCLUSION

This study demonstrated no significant change in STEMI admission trends between the pre- and post-COVID-19 periods, despite a significant increase in the delay from symptom onset to first medical contact. While these delays were evident at the National Heart Center in Tripoli, the standard of care, treatment strategies, and in-hospital outcomes remained largely unchanged. These findings highlight a resilient cardiac care system capable of maintaining clinical consistency, yet they underscore a critical need for public health messaging to ensure timely presentation for cardiovascular emergencies during global health crises

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