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(Research Article)

The impact of acute myocardial infarction on left ventricular ejection fraction in patients admitted to CCU in Al-Kindy Teaching Hospital, Baghdad- Iraq

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Abstract

Background: Acute myocardial infarction affects ventricular wall motion leading to hypokinesia or akinesia of the affected part and this will reduce the ejection fraction of the ventricles. Patients with acute coronary syndrome presented with varying degrees of left ventricular dysfunction. Aim of the study: Assessment of the effect of acute coronary syndrome on left ventricular ejection fraction. Patients and methods: A cross sectional study has been done on 124 patients with acute myocardial infarction admitted to the CCU in Al-Kindy Teaching hospital during the period from June to November 2021. Echocardiography was done for all the patients to measure left ventricular ejection fraction. Results: Left ventricular ejection fraction was significantly lower in patients with STEMI than those with NSTEMI (48.5% versus 53.7%), ($p < 0.05$). Left ventricular ejection fraction was significantly lower in those with extensive MI in comparison to those with anterior and inferior acute myocardial infarction. Left ventricular ejection fraction was lower in older age group. There was no significant difference in Left ventricular ejection fraction reduction between male and female patients. Conclusion: In acute myocardial infarction the reduction in left ventricular ejection fraction depend on type of infarction (STEMI or NSTEMI), site of infarction, age of the patient. There was no significant association between gender of the patient and reduction in left ventricular ejection fraction in patients with acute myocardial infarction.

Keywords: Acute myocardial; Left ventricular ejection; Echocardiography; STMI

1. Introduction

Acute myocardial infarction (AMI) is one of the leading causes of death in the developed world. The prevalence of the disease approaches 3 million people worldwide, with more than 1 million deaths in the United States annually. AMI can be divided into 2 categories: non–ST-segment elevation myocardial infarction (NSTEMI) and ST-segment elevation myocardial infarction (STEMI) (1).

Acute ST-Elevation Myocardial Infarction (STEMI) is a severe form of heart attack characterized by a complete blockage of blood flow to a portion of the heart muscle, leading to tissue death. It is a serious and fatal cardiovascular emergency manifested by ST-segment elevation on electrocardiogram (ECG) which indicates that the heart muscle is being starved of oxygen for a prolonged period(2).

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NSTEMI is diagnosed in patients determined to have symptoms consistent with ACS and troponin elevation but without ECG changes consistent with STEMI. Unstable angina and NSTEMI differ primarily in the presence or absence of detectable troponin leak (3).

The hallmark electrocardiogram (ECG) features of STEMI are ST-segment elevation of 1 mm or more in two or more contiguous limb or chest leads. Non-ST elevation ACS is further categorized according to the presence of biomarkers of cardiac injury (troponin Tor l) in the serum, NSTEMI is defined as a biomarker positive presentation that does not meet the criteria for STEMI (4).

Left ventricular ejection fraction (LVEF) is one of the most commonly reported measures of left ventricular systolic function. It is the ratio of blood ejected during systole (stroke volume) to blood in the ventricle at the end of diastole (end-diastolic volume). If the LV end-diastolic volume (EDV) and end-systolic volume (ESV) are known, LVEF can be determined using the following equation: LVEF = stroke volume (EDV - ESV) ÷ EDV (5).

Many imaging modalities can measure LVEF. Each of these modalities is subject to measurement errors that can lead to the inaccurate calculation of LVEF. The most commonly used imaging modalities are echocardiography, magnetic resonance imaging (MRI), computed tomography (CT), radionuclide angiography, gated myocardial perfusion single-photon emission computed tomography (SPECT) and gated myocardial perfusion positron emission tomography (PET) (6).

An echocardiogram can be used to evaluate all four chambers of the heart. It can determine the strength of the heart, the condition of the heart valves, the lining of the heart, and the aorta. It can be used to detect a heart attack, enlargement or hypertrophy of the heart and infiltration of the heart from an abnormal substance. Weakness of the heart, cardiac tumors and a variety of other findings can be diagnosed with an echocardiogram. With advanced measurements of the movement of the tissue with time (Tissue Doppler), it can measure diastolic function, fluid status, and ventricular dyssynchrony.(6)

Many methods have been developed to measure LVEF using echocardiography. The methods differ based on the type of echocardiographic image used (M-mode, 2D or 3D), the measurements needed and the equations/assumptions used to determine LV volumes. The measurements obtained can be linear (1D), area (2D) or volume (3D) measurements. Advantages of all echocardiographic techniques include lack of ionizing radiation and portability (7).

The modified Quinones method is commonly used and employs linear measurements. It uses single measurements of the LV cavity in the mid-ventricle in both end-diastole and end-systole, and can be employed using either M-mode or 2D imaging. Because only two linear measurements are needed, the modified Quinones method often requires less time to perform than other methods and only needs adequate visualization of the endocardium in the mid-ventricle. However, because this method only measures circumferential contraction in a single plane, significant assumptions about LV chamber geometry have to be made so that a change in a linear measurement can act as a surrogate for a change in volume. The contribution from longitudinal contraction on LVEF is not directly measured, but rather a correction factor is used to adjust the measured LVEF based on a visual grading of the apical contraction (8).

Other methods that use only linear measurements have also been previously described, but have fallen out of favor because of similar limitations. The biplane method of disks (modified Simpson method) is a 2D echocardiographic technique requiring area tracings of the LV cavity. This method is recommended by the American Society of Echocardiography for measuring LVEF. It requires tracing the LV endocardial border in the apical 4- and 2-chamber views in both end-diastole and end-systole (7,8).

The tracings are used to divide the LV cavity into a predetermined number of disks (usually 20) with disk volumes based on the tracings. The method requires fewer geometric assumptions of LV shape than the modified Quinones method, and it directly measures the contribution of longitudinal contraction; however, some geometric assumptions still need to be made, because not the entire LV cavity border is traced. Also, the four tracings take longer to record than the two measurements needed with the modified Quinones method. Other methods that use area measurements of the LV cavity have also been described (7,8,9).

1.1. Aim and Objectives of the study

- Measurement of left ventricular ejection fraction in patients with AMI admitted to CCU in Al-Kindy teaching hospital.
- Study the relation between the sites, the type of AMI (STEMI, NSTEMI), the age and the gender of the patient with left ventricular ejection fraction.

2. Patients and methods

A cross sectional study has been done in the CCU in Al-Kindy Teaching hospital during the period from June to November 2021. The study was carried out on 124 patients with AMI admitted to the CCU, 76 (61%) of these patients were male and 48 (39%) were female.

All patients were subjected to:

- Full history of chest pain and its associated features.
- Full clinical examination; general and systematic.
- ECG was done for all patients.
- Blood investigations including serum troponin were done for all patients.
- Echocardiography machine was available in the CCU of Al-Kindy teaching hospital. Transthoracic M-mode and 2 dimensional echocardiography were done for all patients in the CCU to measure LVEF within one week from the onset of AMI.

2.1. Inclusion criteria

- Patients with AMI, who have no anyone of the exclusion criteria.

2.2. Exclusion criteria

- Patients with history of previous heart failure.
- Patients with heart diseases that affect left ventricular ejection as ischemic heart diseases, cardiomyopathies, rheumatic heart diseases, valvular heart diseases and Left Bundle Branch Block..

Twelve leads standard ECG (electrocardiography) was done for all patients for diagnosis of AMI using Contec Ce (Contec Medical System Co., Ltd. China) and UN 8006 (Wuhan Union Medical Technology Co., Ltd. China) ECG machines. The patients were divided into two groups according to the type of AMI:

- Group one: patients with ST elevation myocardial infarction (STEMI), which include 86 (69%) patients.
- Group two: patients with non-ST elevation myocardial infarction (NSTEMI), which include 38 (31%) patients.

Cardiac troponin I (cTn I) test was done using rapid troponin I test kits (Cross Bio-Medical Co., Ltd., Beijing, China). When blood sample is added to sample pad, it moves through the conjugate pad and mobilizes anti-cTnI that is coated on the conjugate pad. The mixture reacts with anti-cTnI antibody that is coated on the test region. If cTnI is present at levels of 0.11 ng/mL or 1.5 ng/mL or greater the result is the formation of a colored band in the test region. If there is no cTnI in the sample, the area will remain colorless. Result is obtained in less than 15 minutes.(10)

Transthoracic echocardiography: Vivid e 3 GE echocardiography machine from general electronic, healthcare manufacturing company, Chicago USA was used in the current study.

M-mode and 2D echocardiography was done for all patients after admission to the CCU. Left ventricular ejection fraction (LVEF) was measured by single measurements of the LV cavity in the mid-ventricle in both end-diastole and end-systole.

LVEF = {left ventricular end-diastolic volume (EDV)– left ventricular end-systolic volume (ESV) ÷ left ventricular end-diastolic volume).

The heart valves, atrial and ventricular enlargement or hypertrophy, and the movement of the ventricular wall were examined by echocardiography.

2.3. Statistical analysis and data management

The Statistical Package for Social Sciences (SPSS, version 18) was used for data entry and analysis. Chi ($\chi 2$) square test of association was used to compare proportions of different factors among sample groups. Unpaired Student t test, one –way and two ways ANOVA was used to compare means of numerical variables. P value of ≤ 0.05 was regarded as statistically significant.

3. Results

One hundred twenty-four patients were included in this study. The patients were classified into two groups;

- STEMI, which include 86 (69.4%) patients.
- NSTEMI, which include 38 (30.6%) patients.

The range of EF of patients included in this study was 32 – 56% for STEMI and 43 – 59% for NSTEMI. The mean of LVEF was 48.5% in patients with STEMI and 53.7% in NSTEMI. LVEF was significantly lower in patients with STEMI than those with NSTEMI ($p < 0.05$) as shown in Table (1).

Table 1 Relation of EF with the type of AMI

Type of AMI	LVEF%		p-value
	Mean	SD	
STEMI	48.5	8.73	< 0.05
NSTEMI	53.7	11.57	

Patients with anteroseptal and anterolateral were included with anterior AMI, while patients with right ventricular infarction were included with inferior AMI.

In STEMI reduction in LVEF was statistically significant in those with extensive AMI in comparison to those with anterior and inferior AMI ($p<0.05$, $p<0.005$ respectively), also reduction in LVEF was statistically significant in those with anterior AMI than those with inferior AMI ($p<0.05$).

In NSTEMI although there were differences in LVEF regarding the site of infarction, but these differences were statistically not significant ($p>0.05$) as shown in Table (2).

Table 2 Association of EF with the site of AMI

Type of AMI	Site of AMI	Number of patients (%)	EF%		P- value
			Mean	SD	
STEMI	Extensive	23 (26.7%)	44.29	9.28	> 0.05
	Anterior	36 (41.8%)	49.21	10.12	
	Inferior	27 (31.5%)	52.18	11.07	
NSTEMI	Extensive	8 (21%)	49.83	9.76	< 0.05
	Anterior	19 (50%)	52.91	11.09	
	Inferior	11 (29%)	54.72	12.38	

The mean age and standard deviation for all patients were 63.83 (13.12) years. The mean age and standard deviation for those with STEMI were 64.79 (9.68) year, and for NSTEMI were 62.91 (10.33) year.

LVEF was relatively preserved in younger patients. In STEMI group the reduction in LVEF in patients above 70 years old was significant in comparison with those 50 – 59 years old ($p<0.05$), and highly significant in comparison with those below 50 years old ($p<0.005$). Also LVEF was significantly reduced in those 60 – 69 years old when compared to those below 50 years old ($p<0.05$), but there was no significant difference in EF reduction between those 50 – 59 and 60 – 69 years old ($p>0.05$).

In NSTEMI group the reduction in LVEF in patients above 70 years old was significant in comparison with those below 50 years old ($p<0.05$), otherwise there was no significant differences among other age groups as shown in table 3.

Table 3 Relation of EF to the age of the patients

Type of AMI	Age of the patients	Number of patients (%)	EF%		P- value
			Mean	SD	
STEMI	50 >	9 (10.4%)	54.29	8.26	< 0.05
	50 – 59	28 (32.5%)	51.86	9.74	
	60 – 69	37 (43%)	48.67	11.37	< 0.05
	70 ≤	12 (13.9%)	43.35	7.69	
NSTEMI	50 >	7 (18.4%)	57.54	7.04	> 0.05
	50 – 59	12 (31.6%)	54.91	8.39	
	60 – 69	10 (26.3%)	50.42	8.10	> 0.05
	70 ≤	9 (23.7%)	48.83	6.71	

In this study 76 (61.3%) patients were male (52 STEMI and 24 NSTEMI), and 48 (38.7%) patients were female (34 STEMI and 14 NSTEMI). There was no significant difference in LVEF reduction between male and female patients in both STEMI and NSTEMI groups ($p > 0.05$) as in table 4.

Table 4 Relation of EF with the gender of the patients

Type of AMI	**Gender**	**Number of patients (%)**	**EF%**		**p-value**
			Mean	SD	
STEMI	Male	52 (60.4%)	49.93	10.16	> 0.05
	Female	34 (39.6%)	48.84	11.42	
NSTEMI	Male	24 (63.1%)	53.54	9.14	> 0.05
	Female	14 (36.9%)	54.31	8.83	

4. Discussion

In the current study STEMI was more common than NSTEMI, 86 versus 38 patients (69.4% vs 30.6%), Chung (11) reported that 61.9% of patients with AMI had STEMI and 38.1% had NSTEMI.(Olga (12) found that 51% of patients with acute coronary syndrome had STEMI and 49% had NSTEMI, but in that study patients with unstable angina were included in NSTEMI, while in the present study patients with unstable angina were excluded.

In this study LVEF was 32 – 56% (mean 48.5%) in patients with STEMI and 43 – 59% (mean 53.7%) in patients with NSTEMI ; a similar range of LVEF was reported by Brooks et al (13) in study involved 231 patients with AMI. Many studies found that LVEF is significantly lower in STEMI than NSTEMI. Olga et al (12) found that LVEF was significantly reduced in STEMI than NSTEMI, also Zhang et al (14)reported that LVEF was significantly reduced in patients with

STEMI when compared to NSTEMI (52.4% versus 57.1% respectively). Chung et al (13) reported that 34.4% of patients with NSTEMI had LVEF >50% versus 15.4% of patients with STEMI, and LVEF was higher in NSTEMI than STEMI. Amy et al (16) found that LVEF was less than 50% in 42.3% of NSTEMI patients and 50.5% of STEMI patients.(15) Sheeren K reported that 51.3 % of patients with STEMI and 28.3% of patients with NSTEMI had LVEF below 50%.

Other study revealed that the most common Echocardiographic findings in patients with AMI were regional wall motion abnormalities (STEMI vs NSTEMI, 100%, 68.96% respectively); the effect of subendocardial infarction on ventricular wall motion is less than transmural infarction. In majority of the patients with AMI LVEF was 40 – 49%, in 9.52% of NSTEMI and 27.58% of STEMI LVEF was < 40%, only 19.04% of STEMI and 24.23% of NSTEMI had LVEF > 50%.(17)

In the present study in patients with STEMI reduction in LVEF was statistically significant in those with extensive AMI in comparison to those with anterior and inferior AMI ($p<0.05$, $p<0.005$ respectively), also reduction in LVEF was statistically significant in those with anterior AMI than those with inferior AMI ($p<0.05$).

Brain et al (18) found that the mean LVEF was significantly lower in anterior than in inferior myocardial infarction (44.8% versus 53%). Site, size and extent of apical involvement were independent determinants of LVEF, and LVEF was lower in extensive and anterior AMI.

Bimal et al (19) reported that anterior, anteroseptal and extensive MI were responsible for 57.6%, inferior MI for 30.4%, lateral wall MI for about 6% and posterior wall MI was responsible for about 4% of AMI, anterior wall infarctions cause more ventricular enlargement and more reduction in LVEF, and reduction in LVEF increase with increasing infarct size.

Kjell I et al found that 78.8% of patients with anterior STEMI and 43.3% of patients with inferior STEMI had LVEF below 50%.(20)

Sheeren et al (16) reported that 69.4% of patients with extensive MI had LVEF < 40%.

Hafiz (21) reported that the mean LVEF in patients with AMI was 50.5%. In inferior AMI the mean LVEF was 54.93%, while in patients with anterior AMI it was 46.07%. Signs of left ventricular failure were found in 53% of patients with anterior MI and 13.3% of patients with inferior MI.

Shivpuje et al (22) reported that normal wall motion usually excludes transmural infarct. Transmural AMI is always associated with akinesia or dyskinesia. Wall motion abnormality was present in all patients of anterior AMI and extensive AMI, whereas incidence of wall motion abnormality was 78.5% in patients of inferior AMI.

In most of the previous studies LVEF was significantly lower in anterior and extensive NSTEMI than inferior NSTEMI. In the present study this difference was statistically not significant probably because of small sample size (only 38 patients), bias is possible.

In the present study the mean age of the patients were 63.83 years, (64.79 years in STEMI group and 62.91 years in NSTEMI group). LVEF was lower with increasing age.

Most of the previous studies found that in patients with AMI the LVEF reduced with age. Zhang et al (14) found that the mean age of patients with AMI was 64 years and LVEF was significantly reduced with age in STEMI. In Amy et al (15) study the mean age of the patients was 63.1 years in STEMI, and 65.9 years in NSTEMI and LVEF was lower in older groups. Jung et al (23) reported highly significant reduction in LVEF in patients with AMI above 70 years old. Sheeren et al (16) reported that in patients with AMI the LVEF was significantly reduced in elderly patients above 65 years in comparison to other age groups.

Kjell et al (20) found that age > 70 years associated with significant reduction of LVEF in patients with AMI. Olga et al (12) found that the age was consistent predictor for LVEF decline in patients with AMI. Nikolas (24) reported that in patients with AMI age > 70 years associated with low LVEF and increased death risk.

Jiung et al (25) found that the mean age of patients with AMI was 63.1 years, and LVEF decreased with increasing age.

Vijay et al (26) found no significant difference in LVEF with age, probably because most of the patients in that study were young (mean age was 50.2 years) and the study was done in tertiary care referral center, and most of the patients were referred to that center because of AMI with low LVEF.

In this study 76 (61.3%) patients were male and 48 (38.7%) patients were female. No significant difference was found in LVEF regarding the gender of the patients.

Shivpuje et al (22) found that 64% of patients with AMI were male and 36% were female because risk factors as smoking and hypertension are more common in male.

Jiung et al (25) found that 71.55% of patients with AMI were male and 28.45% were female, and there was no significant difference in LVEF between male and female patients. Vijay et al (26) reported that 73.2% of patients with AMI were male 26.8% were female, and there was no significant difference in LVEF regarding patients gender.Many other studies found no significant difference in LVEF between male and female patients with AMI(12,15,20)

5. Conclusions

- Reduction in LVEF was significantly more in STEMT than NSTEMI.
- The impact of extensive AMI on LVEF was more than anterior AMI. Inferior AMI had the least effect on LVEF.
- In AMI the reduction in LVEF increased with age.
- In AMI there was no significant difference in LVEF reduction between male and female patients.

Compliance with ethical standards

Disclosure of conflict of interest

The author declares no conflict of interest. The manuscript has not been submitted for publication in other journal.

Statement of Ethics approval

Approval number: 226 on 3/3/2021.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Author contributions

Mousa Qasim Hussein was involved in the study design and development of research articles including data collection. Ghazwan Hussain Hamodi Al-Khazraji، Suhad Jassim Mohammed، and Yehia Kassem Hossein are writing the entire manuscript including data analysis and interpretation.

AI usage declaration

We confirm that we did not use artificial intelligence in writing this research in any way.

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