Section: Medicine (Cardiology)

Original Research Article

COMPARATIVE ANALYSIS OF INDEX LEFT VENTRICULAR SYSTOLIC DYSFUNCTION FOLLOWING VARIOUS MODES OF REVASCULARIZATION

A. N. Senthil[1], Ranjith. K[2], J. Nambirajan[3], D. Chakkravarthy[4], D. Manikandan[5], J. Jegadeesh[6]

[1]Assistant Professor, Coimbatore Medical College & Hospital, Tamil Nadu, India
[2]Senior Resident, Coimbatore Medical College & Hospital, Tamil Nadu, India
[3]Prof & HOD of Cardiology, Coimbatore Medical College & Hospital, Tamil Nadu, India
[4]Assistant Professor, Coimbatore Medical College & Hospital, Tamil Nadu, India
[5]Assistant Professor, Coimbatore Medical College & Hospital, Tamil Nadu, India
[6]Assistant Professor, Coimbatore Medical College & Hospital, Tamil Nadu, India

Received : 16/12/2023
Received in revised form : 04/02/2024
Accepted : 22/02/2024

Keywords:
Myocardial infarction, reperfusion therapy, left ventricular ejection fraction, mortality, thrombolysis, percutaneous coronary intervention.

Corresponding Author:
Dr. Ranjith. K,
Email: ranjithkumar28492@gmail.com

DOI: 10.47009/jamp.2024.6.1.408

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (1); 2061-2064

Abstract

Background: Non-communicable diseases (NCDs) are a leading cause of global mortality, with cardiovascular diseases (CVDs) accounting for a significant portion. Timely reperfusion therapy post-ST-segment elevation myocardial infarction (STEMI) is crucial in reducing mortality and heart failure risk. Understanding the impact of reperfusion time, treatment modalities, and patient characteristics on left ventricular function post-myocardial infarction is vital. This study aimed to assess the frequency of reduced left ventricular ejection fraction (LVEF) post-STEMI reperfusion therapy and analyze associated factors, including time to therapy, risk factors, vessel involvement, and treatment type (thrombolysis or PCI). **Materials and Methods:** A prospective observational study was conducted at a tertiary care center involving 80 patients with acute STEMI. Patients undergoing reperfusion therapy (thrombolysis or PCI) were included, with data collected on demographics, reperfusion times, LVEF, and outcomes. Statistical analyses assessed associations between variables using Excel and SPSS. **Result:** The mean age of participants was 55.15 ± 4.13 years, predominantly male (78.8%) with 56.3% having diabetes mellitus. Mortality was observed in 3.8% of cases. Reperfusion within guideline-recommended times was limited. Differences in mortality rates were significant between PCI (3) and thrombolysis (0) groups. However, demographic characteristics, diabetes prevalence, and LVEF based on time to perfusion intervals showed no significant differences between groups. **Conclusion:** The study underscores the impact of timely reperfusion on post-myocardial infarction outcomes. While mortality differences were observed between PCI and thrombolysis, other factors displayed similar distributions. Limitations include sample size and single-center setting, necessitating further research for broader insights into these associations.

INTRODUCTION

The majority of the world's illness burden is attributed to non-communicable diseases (NCDs).[1] Every year, NCDs cause 41 million fatalities, of which 15 million are premature deaths, occurring in the 30- to 69-year-old age range.[2] Low- and middle-income countries account for almost 85% of these preventable fatalities (LMICs).[3] The majority of non-communicable illnesses (NCDs) are cardiovascular diseases, or CVDs. Globally, CVDs account for the majority of morbidity and death from chronic diseases. Inherent biological variables, as well as the impact of social, cultural, and environmental factors, all contribute to the development of CVDs. Chronic heart and blood vascular illnesses are grouped together as CVDs. Coronary artery disease, or CAD, accounts for the majority of cardiovascular ailments. Every person has an underlying predisposition to long-term conditions like NCDs.[4] Despite advancements in heart failure therapy, the rates of mortality and morbidity in individuals with HF remain unacceptably high.[5] Continuous efforts are imperative to decrease the occurrence of HF. A crucial factor influencing heart failure development

post-myocardial infarction is the time taken for reperfusion.[6] Lowering this time, assessed via door-to-balloon or door-to-needle and symptom-to-balloon or symptom-to-needle durations, is vital for improving myocardial salvage and preventing heart failure. Door-to-balloon or door-to-needle durations are predominantly influenced by organizational factors like prompt diagnosis, catheterization laboratory activation, and patient presentation during regular working hours. Symptom-to-balloon or symptom-to-needle durations hinge more on patient-related aspects. The 2013 ACC guidelines recommend 30 minutes for door-to-needle and 90 minutes for door-to-balloon durations, aiming to limit total ischemia time to under 120 minutes.[7]

However, achieving these guideline-recommended times is often unfeasible in the current Indian hospital setup due to various factors such as low public awareness of myocardial infarction symptoms, inadequate ambulance services, staff shortages in hospitals, and limited catheterization laboratories outside tertiary care centers. Reducing reperfusion time not only lowers mortality from myocardial infarction but also demonstrates potential in reducing heart failure post-infarction.[8] Differences in heart failure incidence between percutaneous intervention and thrombolysis are not firmly established. Additionally, the relationship between age, sex, presence of risk factors, and their association with reduced LVEF and heart failure post-myocardial infarction in the Indian context lacks substantial documentation. This study aims to determine how frequently patients experience a decline in left ventricular ejection fraction following an episode of acute ST-segment elevation myocardial infarction (STEMI) when they undergo reperfusion therapy. Additionally, it seeks to analyze the specific characteristics of individuals who develop reduced left ventricular ejection fraction and subsequent heart failure, focusing on factors such as the duration between the onset of symptoms and the commencement of therapy, the presence of established risk factors, and the number of coronary vessels affected. Furthermore, the study intends to investigate potential differences in the incidence of reduced left ventricular function between patients treated with thrombolysis and those who undergo primary percutaneous coronary intervention (PCI).

MATERIALS AND METHODS

This prospective observational study took place at a tertiary care center over a year, spanning from January 15, 2023, to January 15, 2024. The sample size of 80 was determined using OPEN EPI software version 3.01, maintaining a 95% confidence interval and a 20% relative precision.

Study Participants

Patients admitted to CMCH Hospital diagnosed with acute ST Elevation Myocardial Infarction (STEMI) and undergoing reperfusion therapy with either streptokinase or percutaneous coronary intervention (PCI) was included.

Inclusion Criteria

Inclusion criteria encompassed all patients presenting with acute STEMI, undergoing reperfusion with either thrombolysis or primary PCI during the one-year study period

Exclusion Criteria:

Exclusion criteria involved patients with prior history of coronary artery disease, heart failure, or structural heart conditions like valvular or congenital heart disease.

Data collection:

Throughout the study, key timeframes such as the window period and door to needle/balloon time were meticulously recorded. Left ventricular ejection fraction, measured via volumetric method, was assessed by a singular individual to minimize inter-personal variability.

Statistical analysis:

The data underwent entry and analysis via Excel and SPSS (version 21). Descriptive statistics encompassed frequency/percentage for categorical variables and mean/standard deviation (SD) for continuous variables. Associations between variables were examined using Chi-square, Mann-Whitney U, or Kruskal-Wallis tests. Significance was set at a p-value below 0.05, indicating statistically noteworthy relationships or differences between variables.

Ethical considerations

The study received approval from the Institutional Review Board (IRB) of CMCH Hospital, and informed consent was obtained from participants or their legal representatives. Confidentiality of patient information was strictly maintained throughout the study, ensuring compliance with ethical guidelines and regulations.

RESULTS

The mean age of the study participants was 55.15 ± 4.13. Majority (78.8%) of the study participants were males. 56.3% had diabetes mellitus. 57.5% of the study participants presented with Anterior wall MI. Out of 80 study participants, 33 (41.3%) underwent PCI and 47 (58.8%) had underwent thrombolysis. 25%, 25%, 22.5% and 27.5% of the study participants had time to reperfusion of 0 – 3 hrs, 3 – 6 hrs, 6 – 12 hrs and more than 12 hrs respectively. Ejection fraction of more than 55%, 45 – 54% and less than 45% was seen among 28.8%, 40% and 31.3% respectively. Mortality was seen among 3 (3.8%) patients.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Attributes based on time to reperfusion

Time to reperfusion (hrs)	0 – 3	3 – 6	6 – 12	> 12	P value
Mean age	54.9 ± 4.78	55.1 ± 3.95	55.17 ± 3.79	55.41 ± 4.22	0.978
Male gender	15 (75%)	14 (70%)	14 (77.8%)	20 (86.9%)	0.158
Diabetes Mellitus	9 (45%)	7 (35%)	7 (38.9%)	12 (52.2%)	0.476
Anterior wall MI	15 (75%)	12 (60%)	10 (55.6%)	9 (39.1%)	0.028
LVEF < 45%	4 (20%)	9 (45%)	8 (44.4%)	4 (17.4%)	0.895
Mortality	1 (5%)	0	1 (5.6%)	1 (4.3%)	0.785

Table 2: Attributes based on PCI or thrombolysis:

Variables		PCI	Thrombolysis	P value
Number		33	47	
Mean age		56.06 ± 4.09	54.51 ± 4.08	0.116
Male gender		26	37	0.994
Diabetes Mellitus		17	18	0.241
Anterior wall MI		23	23	0.064
Mortality		3	0	0.035
Time to perfusion				
< 3 hours	LVEF > 55%	5	8	0.848
	LVEF < 45 %	6	10	0.648
3 – 6 hours	LVEF > 55%	5	10	0.292
	LVEF < 45 %	5	6	0.582
6 – 12 hours	LVEF > 55%	6	9	0.396
	LVEF < 45 %	5	5	0.596
> 12 hours	LVEF > 55%	6	8	0.806
	LVEF < 45 %	8	10	0.474

Table 3: Attributes based on number of vessels involved:

Variables		1 vessel	2 vessels	3 vessels	P value
Number		37	25	18	
Mean age		54.7 ± 4.48	55.4 ± 3.84	55.72 ± 3.88	0.698
Male gender		28	19	16	0.490
Diabetes Mellitus		18	8	9	0.359
Anterior wall MI		19	16	11	0.577
Mortality		1	0	2	0.150
Time to perfusion					
< 3 hours	LVEF > 55%	8	2	3	0.746
	LVEF < 45 %	9	4	3	0.535
3 – 6 hours	LVEF > 55%	4	7	4	0.382
	LVEF < 45 %	4	4	3	0.930
6 – 12 hours	LVEF > 55%	4	8	3	0.803
	LVEF < 45 %	1	7	2	0.110
> 12 hours	LVEF > 55%	8	3	3	0.871
	LVEF < 45 %	11	3	4	0.903

Table 4: Attributes based on anterior wall or non- anterior wall MI:

Variables		AW MI	Non AW MI	P value
Number		46	34	
Mean age		55.67 ± 4.13	54.44 ± 4.07	0.189
Male gender		35	28	0.498
Diabetes Mellitus		21	14	0.690
Mortality		3	0	0.129
Time to perfusion				
< 3 hours	LVEF > 55%	11	2	0.176
	LVEF < 45 %	13	3	0.197
3 – 6 hours	LVEF > 55%	8	7	0.292
	LVEF < 45 %	8	3	0.199
6 – 12 hours	LVEF > 55%	9	6	0.396
	LVEF < 45 %	6	4	0.671
> 12 hours	LVEF > 55%	6	8	0.806
	LVEF < 45 %	8	10	0.474

DISCUSSION

The study included 80 participants, with a mean age of 55.15 ± 4.13 years. The majority (78.8%) were male, and 56.3% had diabetes mellitus. Among them, 57.5% presented with Anterior wall MI. In terms of treatment, 41.3% underwent PCI while 58.8% received thrombolysis. Ejection fraction was distributed as follows: >55% in 28.8%, 45-54% in 40%, and <45% in 31.3%. Three patients (3.8%) experienced mortality.

Reperfusion time distribution was as follows: 25% within 0-3 hours, 25% within 3-6 hours, 22.5% within 6-12 hours, and 27.5% beyond 12 hours. Two variables affect the reperfusion time. The first phase,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

which spans from the beginning of symptoms to the time of presentation, is dependent upon the patient's knowledge of the signs of coronary artery disease and the accessibility of prompt transportation to the hospital. The later portion is the "door to needle time," which is contingent upon the presence of skilled personnel, an intense cardiac care unit, and a cardiac cauterization lab that is fully functioning.

Numerous studies have demonstrated that improved left ventricular function and decreased mortality are associated with shorter reperfusion times. In a meta-analysis of nine randomised studies including more than 58,000 patients, the Fibrinolytic Therapy Trialists Collaborative Group discovered a substantial correlation between the benefit of mortality and the time to reperfusion, up to 12 hours. According to data from GUSTO Trial, thrombolysis can reduce mortality for up to 12 hours (5.3% at 2 hours, 5.9% at 2 to 4 hours, 8.5% at 4 to 6 hours, and 8.9% at 6 hours).[9] The prevalence of diabetes mellitus displays no substantial difference between these groups (AW MI: 21, Non AW MI: 14, p = 0.690). Regarding mortality, there is a numerical difference between AW MI (3) and Non AW MI (0), which is not statistically significant (p = 0.129). Analysing time to perfusion intervals against left ventricular ejection fraction (LVEF) indicates no significant differences between AW MI and Non AW MI groups across various time intervals for both LVEF > 55% and LVEF < 45%. Overall, the comparison highlights similarities in demographic characteristics, diabetes prevalence, mortality rates, and left ventricular function across time to perfusion intervals between patients with anterior wall myocardial infarction and those with non-anterior wall myocardial infarction. The prevalence of diabetes mellitus exhibits no substantial difference between these treatments (PCI: 17, thrombolysis: 18, p = 0.241). There's a trend, albeit not statistically significant, towards an equal occurrence of anterior wall myocardial infarction (PCI: 23, thrombolysis: 23, p = 0.064). Notably, the mortality rate differs between PCI (3) and thrombolysis (0) groups, showing statistical significance (p = 0.035). Analyzing time to perfusion intervals against left ventricular ejection fraction (LVEF) indicates no significant differences between PCI and thrombolysis groups across various time intervals for both LVEF > 55% and LVEF < 45%. Overall, the comparison highlights distinct mortality rates between PCI and thrombolysis groups, whereas other factors like age, gender distribution, diabetes mellitus, anterior wall MI, and LVEF based on time to perfusion intervals do not exhibit significant differences between these treatment approaches. In the Brodie BR et al. trial,[10] there was no discernible difference between the PCI and thrombolysis groups during the first six hours, but the PCI group fared better from six to twelve hours. This was explained by the fact that thrombolysis was only administered during the first six hours after the study was over. The larger area of the myocardium that becomes involved as the duration of vessel non-patency increases and the expansion of the infarction zone as the previously stunned myocardium starts to undergo necrosis as the length of ischemia increases may be the causes of the presence of decreased LVEF as time to reperfusion increases.

CONCLUSION

In conclusion, this study underscores the importance of reperfusion time in myocardial infarction management and its impact on left ventricular function and mortality. While significant differences were observed in mortality rates between PCI and thrombolysis groups, other demographic and clinical factors showed similar distributions across various time-to-reperfusion intervals and myocardial infarction types. However, this study has limitations. The sample size may restrict the generalization of findings, and the single-center setting might limit its broader applicability. Additionally, the observational nature of the study may pose confounding factors that need further exploration. Despite these limitations, the study highlights the critical role of timely reperfusion therapy in improving outcomes post-myocardial infarction. Further research with larger cohorts and multi-center designs could provide deeper insights into these associations.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556