Original Article

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The Impact of Hospitalization Time on Major Cardiovascular Event Frequency in Patients with ST-Elevation Myocardial Infarction Over a 6-Month Follow-up

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Abstract

Aim: The mortality rates related to acute myocardial infarction have significantly decreased recently due to early-period cardiovascular interventions. Some studies have shown that there is no difference in cardiovascular outcomes between the early discharge and the late one. In this study, we planned to investigate the effects of early and late discharge on the frequency of major events in patients treated for acute ST-segment elevation myocardial infarction (STEMI) in our clinic.

Methods: Angiography records, demographic characteristics, and laboratory parameters of the patients who were diagnosed with acute STEMI in our clinic between February 2020 and December 2021 were examined. Patients were classified as being in Group 1 (discharge within 48 h) or Group 2 (discharge after 48 h), and rates of recurrent hospitalization, heart failure attacks, cardiovascular events, and death were compared between the two groups.

Results: A total of 321 patients were included in our study. There were 129 patients in Group 1 and 192 patients in Group 2. There was no difference between the two Groups in terms of gender, age, or affected coronary vessels. The ejection fraction was lower in the late discharge group (p=0.004). The postoperative ventricular arrhythmia rate was found to be statistically significantly higher in the late discharge group (p=0.046). There was no difference in cardiovascular events between the first and sixth months in either group (p-values of 0.096 and 0.649, respectively).

Conclusion: Considering the positive economic and psychosocial effects of early discharge for the patient and physician, when planning the discharge of patients with STEMI, patients with low comorbidity, unaffected ejection fractions, no malignant arrhythmia in their follow-up, and appropriate laboratory parameters can be evaluated for early discharge.

Keywords: Angiography, coronary vessels, heart failure, patient discharge, ST-segment elevation myocardial infarction

Introduction

Atherosclerotic cardiovascular diseases are the ones that rank first with their mortality and morbidity rates worldwide (1). ST-segment elevation myocardial infarction (STEMI) continues to be the leading cause of cardiac emergency visits among atherosclerotic heart diseases. The goal of treating these diseases is to restore impaired myocardial blood flow. A reperfusion strategy is recommended as early as possible to minimize cardiac damage. Improvements in treatment options and hospital facilities, the adoption of guided medical treatments, and evidence-based preventive measures have all contributed to an improved prognosis for patients with STEMI. However, re-infarction, stent thrombosis, malignant arrhythmias, heart failure, and other mechanical complications are seen in a significant number of patient groups. These complications require monitoring of patients in the coronary care unit for at least 24-48 hours (2).

European Society of Cardiology (ESC) Guidelines recommend that low-risk patients be discharged within 72 hours with appropriate follow-up and early-term rehabilitation planning for patients with STEMI (3). Due to advances in management strategies and the use of evidence-based medical treatments, there is a trend toward shorter hospital stays for patients with STEMI. Different scoring systems [such as the Zwolle risk score (ZRS), the controlled abciximab and device investigation

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to lower late angioplasty complications (CADILLAC) risk score, and the primary angioplasty in myocardial infarction (PAMI) and Canadian assessment of myocardial infarction (CAMI)-STEMI risk scores] have been studied to calculate the risk of patients scheduled for early discharge, and the high patient safety and cost-effectiveness of reducing the length of hospital stay have been demonstrated by recent studies (4-6).

The feasibility of early discharge after primary percutaneous coronary intervention (PCI) in patients with STEMI varies according to the socioeconomic levels of the countries and the income levels of the individuals. Appropriate and evidence-based adoption of an early discharge strategy can have a significant financial impact for both the patient and the hospital (7,8). This study aims to evaluate the relationship between the discharge times of patients with STEMI in a tertiary heart center and the frequency of cardiovascular events in the first and sixth months after discharge, and to create a roadmap for the discharge process of patients considering the data to be obtained.

Materials and Methods

Compliance with Ethical Standards

This study was conducted in accordance with the principles of the Declaration of Helsinki. The ethics committee's approval was received at the meeting of the Ethics Committee of Necmettin Erbakan University, Non-Pharmaceutical and Medical Device Researches, dated March 4, 2022, and numbered 149 (decision no: 3681).

Study Design

This study was planned as an observational retrospective study, including patients with STEMI (n=321) who were admitted to our hospital between February 1, 2020, and December 31, 2021, underwent successful PCI, and were subsequently discharged.

Patient Evaluation and Follow-up

In our study, 321 patients were divided into two groups according to their discharge time: those who were discharged before 48 hours (n=129) and after 48 hours (n=192) (Figure 1). Those who died during hospitalization were excluded from the study. All patients within the specified period were included in the study and had no additional exclusion criteria. Demographic characteristics of the patients, cardiovascular risk factors, additional diseases, hemograms, biochemistry tests, and kidney and liver function tests were recorded. The Cockroft-Gault formula was used to calculate the patients' glomerular filtration rate, and the neutrophil x platelet, /lymphocyte formula was used to calculate the systemic immune inflammation index (9). Lipid profile values, troponin values, C-reactive protein (CRP) values, and HbA1c values in the blood collected during the hospitalization of the patients were recorded. During the hospitalization period, the blood values taken before discharge were compared with the values at the time of initial admission. All patients had coronary angiography performed via the femoral route. Coronary angiography images of the patients were examined, and the coronary artery with the lesion responsible for STEMI and the vessel with the additional severe lesion were recorded. After these records were scanned, other data were obtained from the hospital's automation system. Then, in the follow-up of the patients, it was learned whether they had a major cardiac event in the 1st and 6th months after discharge, by scanning on www.enabiz.gov.tr and by contacting the registered phone numbers in the hospital system for the patients whose information could not be accessed. Patients who were not treated in our clinic, patients whose information was missing in the file examination, and patients whose information could not be reached were excluded from the study.

Statistical Analysis

Evaluation of the research data was obtained using SPSS 20.0. In the results of the study, the mean values according to the distribution of the data were used for quantitative variables as descriptive statistics, and the number of cases (percentage) was given for qualitative variables. In the study, the normality assumptions of the data were checked by considering the Kolmogorov-Smirnov test, skewness, and kurtosis values. After checking the normality assumptions, cross tables and chi-square statistics were used to control the relationships, a t-test was used for the data showing normal distribution in comparisons for the two groups, and Mann-Whitney U statistics were used for the data that did not show normal distribution. A p-value of 0.05 or less was considered significant in all tests.

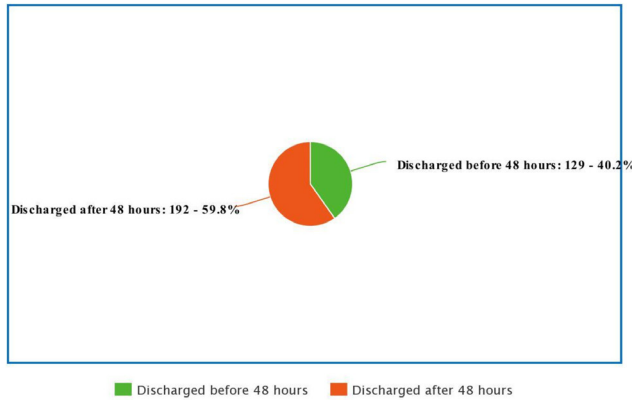

Figure 1. Distribution of groups

Results

The mean hospital stay of the patients included in Group 1 was found to be 37.2±8.9 h. The mean hospital stay of 192 patients in Group 2 was calculated as 110.1±88. There was no significant difference between the two groups in terms of gender or age. Although there was no statistically significant difference between the two groups in terms of comorbidities such as diabetes mellitus, hypertension, chronic renal failure, COPD (chronic obstructive pulmonary disease), and malignancy, these comorbidities were found to be more common in Group 2 (Table 1).

When the coronary angiographies of the patients in both groups were examined, it was seen that the left anterior descending artery was most affected, but no significant difference was observed between the coronary arteries responsible for the cardiovascular event. Serious lesions were detected in other coronary arteries, different from the main coronary artery responsible for the cardiovascular event in the groups (46.5%) and (44.7%), respectively. The mean ejection fraction in Group 2 was 45.1% and was found to be statistically significantly lower than the other group (p=0.004). In Group 2, the rate of atrial fibrillation was higher at the time of admission, and

Table 1. Comparison of demographic data and comorbidities of the patients

Discharge times	First 48 hour (n=129)	>48 hour (n=192)	p-value
Age (years, mean±SD)	60.26±11.02	61.38±13.37	0.482
Gender (male, n, %)	114 (88.37)	164 (85.41)	0.723
Diabetes mellitus (n, %)	39 (30.23)	53 (27.61)	0.617
Hypertension (n, %)	47 (36.43)	78 (40.62)	0.451
Chronic renal disease (n, %)	14 (10.85)	31 (16.14)	0.194
Hemodialysis (n, %)	2 (1.55)	1 (0.52)	0.461
COPD (n, %)	5 (3.87)	13 (6.77)	0.269
Malignancy (n, %)	6 (4.65)	13 (6.77)	0.481

Mann-Whitney U test, Student's t-test, chi-squared test, One-Way ANOVA tests were used in appropriate
COPD: Chronic Obstructive Pulmonary Disease, SD: Standard deviation

Table 2. Comparison of the perop and postoperative characteristics of the patients

Discharge times	First 48 hour (n=129)	>48 hour (n=192)	p-value
Culprit lesion - RCA (n, %) - CX (n, %) - LAD (n, %)	 46 (35.65) 28 (21.71) 55 (42.63)	 65 (33.85) 36 (18.75) 91 (47.39)	0.672
Another severe lesion (≥70%) (n, %) - None - RCA - CX - LAD - Multivessel	 60 (46.51) 43 (33.33) 7 (5.42) 10 (7.75) 9 (6.97)	 86 (44.79) 57 (29.68) 17 (8.85) 20 (10.41) 12 (6.25)	0.759
Heart rate (n, %)	69.30±23.87	67.63±24.64	0.551
Systolic blood pressure (mmHg, n, %)	131.41±24.95	132.18±28.06	0.801
Diastolic blood pressure (mmHg, n, %)	77.07±12.23	76.43±15.38	0.696
Ejection fraction (n, %)	48.08±7.61	45.14±9.09	**0.004**[1]
End-diastolic diameter (mm, n, %)	47.67±4.51	48.56±5.04	0.118
End-sysctolic diameter (mm, n, %)	30.44±5.17	31.96±6.84	**0.038**[1]
Left atrium (mm, n, %)	37.48±3.69	38.36±4.46	0.073
Sinus ryhtm (mm, n, %)	123 (95.34)	177 (92.18)	0.341
Atrial fibrillation (n, %)	6 (4.65)	15 (7.81)	0.421
Postoperative atrial fibrillation (n, %)	4 (0.311)	12 (6.25)	0.296
Postoperative ventricular arrhytmias (n, %)	1 (0.77)	7 (3.64)	**0.046**[1]
MACE for 1 months (n, %)	13 (10.07)	32 (16.66)	0.096
MACE for 6 months (n, %)	17 (13.17)	22 (11.45)	0.649

[1]: Chi-squared test Mann-Whitney U test, Student's t-test, Chi-squared test, One-Way ANOVA tests were used in appropriate,
RCA: Right coronary artery, CX: Circumflex artery, LAD: Left anterior desending artery, MACE: Major adverse cardiovascular events

atrial fibrillation was more common in the follow-up of the patients. The incidence of ventricular arrhythmia in the post-PCI period was also statistically higher in Group 2. Although the frequency of major cardiac events requiring hospitalization in the 1st and 6th months after discharge was numerically higher in Group 2, no statistically significant difference was found. In Group 1, 1 (0.7%) cardiovascular death occurred within 1 month and 2 (1.5%) within 6 months; in Group 2, 2 (1%) deaths in 1 month and 5 (2%) deaths in 6 months were observed (p≥0.05). Hospitalizations due to heart failure within 6 months were detected for 2 (1%) patients in Group 1 and for 4 (2%) patients in Group 2 (p≥0.05) (Table 2).

When the laboratory parameters of the patients were compared, the systemic immune inflammation index was lower in the early discharge group, although it was not statistically significant. However, the CRP value was higher in the early discharge group than in the late discharge group (Table 3).

Discussion

Ischemic heart disease presents as acute coronary syndrome in more than 50% of patients. Primary PCI is currently the most effective reperfusion method for patients presenting with acute STEMI. Patients presenting with STEMI are monitored for the first 24 hours in terms of risks such as re-infarction, heart failure, mechanical complications, and the development of malignant arrhythmias after revascularization; this period can be extended in high-risk patients (10). The patient's age, Killip class (determined at the time of admission to the hospital), the thrombolysis in myocardial infarction (TIMI) flow after PCI, the number of affected coronary vessels, the responsible lesion, and ejection fraction are predictors

Table 3. Comparison of the blood parameters of the patients at the time of admission and discharge

Discharge times	First 48 hour (n=129)	>48 hour (n=192)	p-value
Laboratory parameters during the first contact			
WBC (mean±SD)	11.22±3.36	11.28±3.52	0.869
NEU (mean±SD)	7.67±3.39	8.09±3.49	0.285
LYM (mean±SD)	2.54±1.54	2.31±1.39	0.142
HG (mean±SD)	15.93±13.43	15.78±15.91	0.930
PLT (mean±SD)	238±66.11	256±80.88	0.035
GFR (mean±SD)	77.47±24.63	73.75±25.22	0.196
CRE (mean±SD)	1.42±1.37	1.17±0.61	0.169
SGOT (mean±SD)	22.57±14.83	24.22±18.44	0.411
SGPT (mean±SD)	33.77±36.81	40.78±46.68	0.165
CRP	12.61 (9.8-34)	15.22 (11- 44)	0.482
LDL (mean±SD)	107.33±38.14	107.84±37.31	0.910
TROPONIN	2.79 (1.1-16)	2.74 (2-6.9)	0.952
HBA1C (mean±SD)	7.62±2.91	7.27±2.66	0.561
SII (mean±SD)	1054±998	1300±1163	0.051
Laboratory parameters during discharge			
WBC (mean±SD)	10.37±2.88	9.62±2.73	**0.023**[1]
NEU (mean±SD)	7.27±2.55	6.46±2.44	**0.006**[1]
LYM (mean±SD)	3.81±1.81	3.22±1.44	0.755
HG (mean±SD)	13.56±1.94	13.61±9.95	0.958
PLT (mean±SD)	218±55.97	234±92.8	0.108
GFR (mean±SD)	78.35±24.97	75.51±2466	0.328
CRE	2.54 (1.45-4.9)	1.46 (1.33-5.4)	0.277
SGOT (mean±SD)	110±14.5	34.18±17.89	**0.004**[1]
SGPT (mean±SD)	43.14±34.4	32.71±20.06	0.362
CRP (mean±SD)	115±65.5	51.94±38.43	**0.005**[1]
Mean hospital duration (mean±SD)	37.24±8.91	110.11±88	**0.001**[2]

[1]: Chi-squared test, [2]: Student's t-test Student's t-test, Chi-squared tests were used in appropriate.
SII: Systemic immun-inflammaton index, WBC: White blood cell, NEU: Neutrophil, LYM: Lymphocyte, PLT: Platelet, GFR: Glomerular filtration rate, CRE: Creatinin, CRP: C-reactive protein

of mortality, as are the other parameters used in clinical practice to identify high-risk patients.

Apart from these parameters, there are various scoring systems designed to identify high-risk patients and patients suitable for early discharge after STEMI. The ZRS, PAMI-II criteria, CAMI-STEMI score, CADILLAC risk score are some of them. Several studies have confirmed that the ZRS is a useful scale for risk stratification. The ZRS score is determined by whether the patient is 60 years old or older, whether the ischemia lasts more than 4 hours, whether there is an anterior wall infarction, TIMI flow after angioplasty, whether the patient has three-vessel disease, and the Killip class that the patient belongs to (11).

In the past years, percutaneous treatment methods were uncommon, and percutaneous techniques were not developed enough, causing delays in revascularization and incomplete reperfusion, which increased the possibility of heart failure, malignant arrhythmia, and mechanical complications. Accordingly, the length of hospital stay and the cost increased significantly, and long hospitalizations caused the patients to be affected psychologically. With the recent spread of percutaneous intervention centers, developments in the field of invasive cardiology have resulted in a shortening of revascularization times. In addition to the developments in this area, because of early rehabilitation and mobilization, the length of hospital stay of patients with STEMI has been significantly shortened, and significant reductions in mortality have been observed recently (12).

Many studies in the literature have examined the relationship between early or late discharge of patients and mortality. One of the earliest studies in this area, which shows the effectiveness of early discharge, is the study by Topol et al. (13) from 30 years ago. This study is among the first to demonstrate the safety of an early discharge strategy in 179 patients with uncomplicated STEMI (no angina, arrhythmia, or heart failure 72 hours after admission). A meta-analysis by Gong et al. (14) in 2018 investigating the safety of early discharge after primary angioplasty in low-risk patients with STEMI was as follows: In five randomized controlled trials involving 1575 patients with STEMI, patients were divided into an early discharge group and a standard discharge strategy group. There was no difference in mortality and readmission rates between the two groups (hazard ratio 0.78, 95% confidence interval 0.50 to 1.22, p=0.41) (14). Several randomized studies in this area have shown that a hospital stay of less than 72 hours is feasible. One of the largest studies conducted recently was by Satılmısoglu et al. (15) patients were divided into two groups in this prospective, randomized, multicenter study (which included 796 patients who underwent primary percutaneous intervention): those who received early discharge (48-56 hours) and those who received a standard discharge strategy. The primary endpoint was death from all causes and hospitalization at day 30. Compared with the standard discharge group, the early discharge group had a significantly shorter hospital stay (45.99±9.12 h vs 114.87±63.53 h; p<0.0001). There was no statistically significant difference between the two groups in the rates of all-cause mortality and readmission to the hospital (p=0.684 and p=0.061, respectively). It has been shown that discharge is feasible and safe 48-56 hours after successful PCI (15). The 2017 ESC STEMI guidelines have raised the recommended early discharge recommendations for low-risk patients with STEMI treated with primary angioplasty from class IIb to IIa (16).

In our study, it was again demonstrated that early discharge is safe. Recurrent hospitalization and death rates were similar in both groups. Additionally, the types and numbers of affected vessels in our patients were similar in both groups. The ejection fractions of the patients in Group 2 were found to be significantly lower than those in the other group, and the lack of a significant decrease in the EF values of the Group 1 patients may be due to early admission and rehabilitation. However, because the admission times of the patients cannot be clearly determined, this should be accepted as an assumption. Simultaneously, the prolonged hospital stay may be due to attacks of heart failure. Actually, although low EF alone does not explain this situation, acute low EF may cause this status and cause the discharge to be delayed by the physician who is following the patients. When the systemic immune inflammation indexes of the patients at the time of admission were compared, they were observed to be lower in the early discharge group, although it was not statistically significant. Recently, there have been many studies showing that inflammatory markers are associated with the severity of coronary artery disease and cardiovascular disease (17,18). At this point, the low inflammatory values of the patients in this period due to early admission may have caused such a result. The patients' high comorbidities, as well as the development of postoperative atrial fibrillation and ventricular arrhythmias, may have necessitated a longer hospital stay. Additionally, it was thought that the high CRP values at discharge of Group 1 patients might be due to hospital-acquired infections. But this finding may also be a coincidence. Furthermore, the femoral artery was the site of intervention in our patients. The length of hospital stay may be reduced if the radial route is used in these patient groups.

There is no clear consensus or guideline recommendation on the length of hospital stay for early discharge after STEMI. Current guidelines are based on

limited data from randomized controlled trials. Studies have shown that mechanical complications, malignant ventricular arrhythmias, large areas of myocardial necrosis, and heart failure often occur within the first 72 hours after admission. All these data support an early discharge strategy for eligible patients. Considering these data, with the widespread use of an early discharge strategy, significant reductions in health costs can be achieved, as can minimizing the psychological impact on patients traumatized by STEMI. Additionally, the possibility of developing disease-related complications in the early period in patients with acute myocardial infarction is still a problem in clinicians' minds at discharge. Especially in late admissions and advanced-age heart attacks, the high probability of complications may prolong the hospital stay. It is a fact that more comprehensive studies are needed, especially in this group of patients (19).

Similar to the existing studies, no statistically significant difference between the early and late discharge groups in low-risk patients observed in our study in terms of mortality and the incidence of undesirable major cardiac events in the first and sixth months.

Study Limitations

There are several limitations to our study. First, this was a retrospective, single-center study that may be subject to selection bias and statistical limitations due to sample size. Therefore, the findings may not reflect the patient population or healthcare performance in other centers. Additionally, the long-term results and cost-effectiveness of patients' follow-up were not evaluated. Additionally, the lack of participants in the young or old population to evaluate the results is another limitation. Despite these limitations, although it is a small-scale study, it can be considered a pioneering study in terms of showing the effectiveness of early discharge after STEMI in our country.

Conclusion

Our study formed an idea in terms of determining the length of hospital stay of patients with STEMI and the parameters that can be used in patients scheduled for early discharge in a tertiary center. However, larger prospective studies are needed to evaluate patient safety as well as the economic and psychological effects of early discharge of patients.

Ethics

Ethics Committee Approval: The ethics committee's approval was received at the meeting of the Ethics Committee of Necmettin Erbakan University, Non-Pharmaceutical and Medical Device Researches, dated March 4, 2022, and numbered 149 (decision no: 3681).

Informed Consent: This was a retrospective, single-center study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Concept: A.T.S., Design: N.A., Data Collection or Processing: N.A., Analysis or Interpretation: Y.A., Literature Search: A.S.G., Writing: A.T.S.

Conflict of Interest: No conflict of interest was declared by the authors.

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