International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 10, Issue 02, February 2025,
https://doi.org/10.23958/ijirms/vol10-i02/2029

Original Article

Safety of the Six-Minute Walk Test in the Acute Myocardial Infarction Phase Performed in Hospital - Observational Cross-Sectional Study

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Received 14 January 2025; Accepted 11 February 2025; Published 15 February 2025

Abstract

The aim of this study was to evaluate the safety of the 6-minute walk test (6 MWT) in uncomplicated myocardial infarction (MI) patients in the acute in-hospital phase. One hundred and thirty patients with acute MI (NSTEMI, non-ST-elevation myocardial infarction; STEMI, ST-elevation myocardial infarction) with percutaneous coronary intervention (PCI) took part voluntarily in this study. The mean age of the patients was 61.4 (SD 11.3), ranging between 25 and 82 years. More than half of the patients were male (74.6%). Physicians in the intensive care unit identified potential participants based on the inclusion criteria and issued prescriptions for physiotherapy treatment. 6 MWT was conducted on the day of discharge. The vital parameters (blood pressure, heart rate, respiratory rate, and oxygen saturation) were measured by physiotherapists at rest, after 6 MWT and after 3 min of recovery. The data were supplemented with Borg Dyspnea and Borg Rating of Perceived Exertion values. The distance covered during 6 minutes was recorded. None of the 130 patients had to discontinue the 6 MWT. The average distance covered by the participants was 442.4±81.1 meters. Four patients (3%) out of 130 reported clinical complications without the need for intervention. The hypothesized 5% complication rate was not reached (p=0.0308). This study gives evidence, that a 6 MWT can be safely conducted in patients with an uncomplicated acute MI. Moreover, a 6 MWT can be considered as a valuable assessment giving prognostic value for cardiac rehabilitation after discharge.

Keywords: ***acute myocardial infarction, 6-minute walk test, safety, submaximal functional capacity.***

Introduction

Coronary heart disease is the most common type of heart disease and is the leading cause of death worldwide [1]. Among cardiovascular illnesses, ischemic heart disease ranks as the most prevalent [2]. Possible consequences in patients who have experienced a myocardial infarction (MI) include: reduced left ventricular ejection fraction, chronic heart failure with reduced cardiovascular fitness and poor exercise tolerance [3,4]. Reduced functional capacity in MI patients has been associated with a worse prognosis compared to MI persons who have no restrictions in everyday life [3]. On the other hand, several studies showed that exercise after MI reduces cardiovascular-related mortality [5-7], by increasing contractility of the myocardium, which results in an improvement of the left ventricular ejection fraction [8].

The 6 Minute Walk Test (6 MWT) is a widely used, simple, low cost, validated, submaximal exercise test to assess the daily activity performance by patients with heart diseases [9,10]. Despite of this, the number of investigations regarding the assessment of the 6 MWT in the acute MI phase prior to discharge is very low [9-12].

A possible explanation might be that the American Thoracic Society (ATS) declared in its main guidelines (2002) the 6 MWT as an absolute contraindication in acute MI [13]. In the update of the ATS from 2014, based on new insights, MI remains an absolute contraindication for 6 MWT, but this is restricted to the first 3 to 5 days after uncomplicated MI [14]. However, we found studies from 2015 up to now, which still consider MI as a contraindication [15-17].

Therefore, the aim of this study was to evaluate the safety of the 6 MWT in uncomplicated acute MI patients before discharge. We hypothesized that less than 5% of the patients develop adverse events such as angina, dyspnea, dizziness, increased level of effort according to the Borg scale or alarming changes in vital parameters such as blood pressure, pulse, respiratory rate, oxygen saturation.

Materials and Methods

This cross-sectional study was performed in the Hospital Kreiskliniken Reutlingen, Germany between April 2023 and April 2024. Ethical approval was obtained from the institutional research ethics committee before recruitment (Reg.Nr. K-2023-002, date of approval 15.04.2023). The study was conducted in accordance with

the principles set forth in the Helsinki Declaration. The participants were informed that they could withdraw from the study at any time. All the enrolled patients signed an informed consent before participation.

Study Population

Patients with acute MI (NSTEMI, non-ST-elevation myocardial infarction; AW STEMI, anterior wall ST-elevation myocardial infarction; PW STEMI, posterior wall ST-elevation myocardial infarction) with percutaneous coronary intervention (PCI) took part voluntarily in the study. The inclusion criteria was acute MI with PCI. The exclusion criteria were palliative patients, patients with dementia or immobility, age > 85 years, in-hospital phase more than 7 days (meaning complications), MI with conservative therapy and isolated patients with acute infection. One hundred fifty patients consented initially to the study. There were 130 (86,7%) patients who completed the study. 15 (10%) patients were only able to complete the 6 MWT after day 7 for various reasons and 5 (3,3%) patients were discharged on the weekend without having completed a 6 MWT.

The demographic characteristics of the study participants (see Table 1): the mean age of the patients was 61.4 (SD 11.3), ranging between 25 and 82 years. More than half of the patients were male (74.6%) with a diagnosis of NSTEMI (53.1%), a reduced left ventricular ejection function (56.6%) and with more than 1 vessel coronary artery disease (71.3%). Most of the subjects had a secondary education level (76.0%), were at that time employed (54.6%) and married (72.3%).

Table 1: The demographic characteristics of the study participants.

		%		%	
Gender	Male	74.6	Coronary Artery Disease (CAD)	1 Vessel CAD	28.7
	Female	25.4		2 Vessel CAD	33.3
				3 Vessel CAD	38.0
Diagnosis	NSTEMI	53.1			
	AW STEMI	19.2	Educational Level	University and college	17.6
	PW STEMI	27.7		Highschool diploma	6.4
				Certificate of secondary education	40.0
LV function	Normal	43.4		General certificate of secondary education	36.0
	Mildly reduced	35.0			
	Moderately reduced	13.2	Employment Status	Employed	54.6
	Severely reduced	8.5		Unemployed	5.4
				Retired	40.0
Marital status	Married	72.3			
	Single/Divorced/Widowed	27.7			

Study Procedure

Physicians at the intensive care unit, intermediate care unit, or cardiology section in Kreiskliniken Reutlingen identified potential participants based on the inclusion criteria and issued prescriptions for in-hospital physiotherapy treatment. A research assistant (physiotherapist working on the above-mentioned sections) conducted the physiotherapy and the 6 MWT on the day of discharge.

The physiotherapeutic treatment in phase I includes the dosed increase in cardiovascular fitness according to the myocardial infarction mobilization plan (see Figure, Supplemental Digital Content, which presents the "Reutlingen Myocardial Infarction Therapy Model") and the education about the rules of conduct in everyday life with the help of a myocardial infarction flyer. On discharge, the patients must have been able to correctly assess the intensity of exertion within the specified limits based on the heart rate monitoring and exertion protocol (Borg scale) and to react adequately to any symptoms that may occur. Patients benefit from this self-assessment training at the 6 MWT.

Outcome Measures

The in-hospital 6 MWT was carried out using a 30-meter long flat, straight, hard surfaced, enclosed corridor [18]. Ideally no vigorous exercise was performed in the 2 hours preceding the 6 MWT. The patients all received the same standardized instructions: "to walk as far as possible within 6 minutes" and the participants were allowed to decide the walking pace themselves. 6 MWT was stopped immediately when angina symptoms occurred, by tachycardia, intolerable dyspnea (≥ 5 Borg Dyspnea Scale), severe fatigue (≥ 17 Borg Rating of Perceived Exertion), oxygen saturation ≤80%, heart rate changes ≥30 beats per minute and subjective complaints such as dizziness, extreme sweating, nausea etc.

To record cardiovascular fitness in patients at each level, the vital parameters (blood pressure, heart rate, respiratory rate, and oxygen saturation) were measured by physiotherapists at rest, after 6 MWT and after 3 min of recovery. The data were supplemented with Borg scale values: Borg Dyspnea Scale (0-10, 0 means no respiratory symptoms at all and 10 maximal difficulty to breath) and Borg Rating of Perceived Exertion - RPE (6-20, 6 meaning no exertion at all and 20 means maximal exertion). The distance covered during 6 minutes was recorded.

Statistical Analysis

The sample size was calculated considering the occurrence of 5% adverse events as significant, with a power of 80% and an alpha set to 5%. G*Power3.1.9.7. [19] was used and the achieved sample size was 127. To account for any loss of participants during the study 130 patients were recruited. To present the sample characteristics we used descriptive statistics including means, standard deviations (SD), and percentages. Binomial test was performed using GraphPadPrism10 [20].

Results

None of the 130 patients had to discontinue the 6 MWT. The average distance covered by the participants was 442.4±81.1 meters. Four patients (3%) out of 130 reported adverse events: 1 person (0.7%) had mild pressure on the thorax and 3 patients (2.3%) had a Borg Dyspnea Scale of > 5 (one value of 6 and two values of 7 were registered). The 5% probability level that a patient will show adverse events was not reached. According to the binomial test p=0.0308 the hypothesis has thus been confirmed.

No hemodynamic adverse events were registered: the average systolic blood pressure change between the rest and load values was 8.38±6.2 mmHg. The change in the heart rate range in before and after comparison was 11.05±7.6 min-1. The average Borg Dyspnea Scale value after loading was 2.2±1.7 and by RPE 8.8±2.1. None of the patients had an oxygen saturation of less than 90% after 6 MWT. No life-threatening serious adverse events (MI, stroke, death, need for escalation in care etc.) occurred during or after the 6 MWT.

Reference data enabled the meaningful interpretation of the submaximal functional capacity test results. When comparing the 6 MWT results of this study from the day of discharge with the international reference values for patients with MI from related studies, similar or even better results were found (see Table 2). The patients walked a mean distance of 442.48 m, which correspond to 74.4% of the expected distance (healthy adults 590.0 m).

Table 2: 6 MWT results in comparison to related studies.

	This study	Qu et al. 2021 [8]	Diniz et al. 2017 [9]	Matos-Garcia et al. 2017 [21]	Peixoto et al. 2015 [22]	Ferreira et al. 2015 [10]	Healthy adults Cazzoletti et al. 2022 [23]
N	130	41	152	54	88	30	530
Age	61.4±11.3	56.8±9.5	55.7±9.7	55.8±11	56.0±9.6	58.5±13.4	46.8±11.8
Gender	Male N=97 Female N=33	Male N=27 Female N=14	Male N=117 Female N=77	Male N=39 Female N=15	Male N=62 Female N=26	Male N=9 Female N=21	Male N=243 Female N=287
Distance in meter	442.48±81.1	256.18±26.8	442.4±75.2	465.1±67.8	436.3±82.3	295.9±81.6	595.0±73.3
Days after MI	5.03±1.2	<7 days	4.0	3.6±0.7	5.15±1.4	2.9±2.0	n.a.
Adverse events	3%	n.a.	3.9%	n.a.	1.14%	16.6%	n.a.

Discussion

Less than 5% of MI patients experienced mild symptoms at the 6 MWT (hypothesis confirmed) which demonstrates the safety of this functional capacity test in the acute phase of uncomplicated MI patients (from the 3rd day after MI). The hemodynamic changes during the test were normal, within physiological limits. Similar alterations have also been reported in other studies [9]. Possibly the administration of beta- blocker agents also had an influence on the relatively low changes in the heart rate and blood pressure values.

Furthermore, the mild symptoms (1x pressure on the thorax and 3x increased subjective perception of fatigue or dyspnea on the Borg scale) disappeared immediately after reducing load intensity, without the need for intervention and without causing life-threatening situations. A plausible explanation for the very low adverse event rate is that the MI patients benefit from the self-assessment training as part of physiotherapy. On the day of discharge, patients were able to assess the intensity of exertion within the specified limits based on the heart rate monitoring and exertion protocol (Borg scale). Hence the possibility of overexertion and the associated adverse events are reduced. Nevertheless, the 6 MWT results of this study were similar or better than the data from other international studies and the mean distance walked was close to the value predicted from healthy subjects [23-26]. These results suggest that MI patients show a relatively high exercise tolerance even in the first phase of an acute MI.

Therefore, this study demonstrates that there is no theoretical or practical evidence [8-11,22] that 6 MWT should not be used from the 3rd day after an uncomplicated acute MI. It is known that the general length of stay in hospital decreases after an MI due to resource optimization and that the in-hospital first phase of MI rehabilitation is the most important [7,27-31]. A modern, effective, yet safe treatment method is needed, so as to provide acute MI patients the best possible care. Based on this aim, the "Reutlingen Myocardial Infarction Therapy Model" [32], (Supplemental Digital Material) is used in Kreiskliniken Reutlingen for MI patients in acute phase I of rehabilitation. An integral part of this therapy method is the 6 MWT on the day of discharge. The level of difficulty for the 6 MWT can be compared with that of basic activity of daily living [33,34]. These conditions correspond with those which will occur in normal everyday life of an MI patient. Hence, our patients are prepared for real life situations by discharge. Moreover, 6 MWT can be considered also a valuable assessment for aerobic capacity and endurance [11,35] and can be used as a prognostic value for cardiac rehabilitation after discharge [10,33,36].

Limitations: Study population was a mixed cohort, in which ~50% of the participants had normal left ventricular ejection fraction (LV function) and ~50% had reduced LV function. The risk for adverse events may be different between those patients with normal and reduced LV function. Further studies are needed to analyze the adverse events rate in the group of MI patients with normal and reduced LV function.

Furthermore, the MI patients with complication, who are most likely to experience an adverse event during the 6 MWT were excluded (according to the recommendation of the ATS).

Conclusions

- In a cohort of patients evaluated in-hospital after uncomplicated MI with PCI, our data suggest that a 6MWT completed 3 or more days after the index event appears to be safe.
- The level of difficulty for the 6 MWT can be compared with that of basic activity of daily living, hence the patients are prepared for real life by discharge.
- The 6 MWT can be considered also a valuable assessment for aerobic capacity and endurance and can be used as a prognostic value for cardiac rehabilitation after discharge.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the institutional research ethics committee before recruitment (Reg.Nr. K-2023-002, date of approval 15.04.2023). The study was conducted in accordance with the principles set forth in the Helsinki Declaration. All the enrolled patients signed an informed consent before participation.

List of abbreviations

AW-STEMI: Anterior wall ST-elevation myocardial infarction
CAD: Coronary artery disease
LV function: Left ventricular ejection fraction
NSTEMI: Non-ST-elevation myocardial infarction
PW-STEMI: Posterior wall ST-elevation myocardial infarction
6 MWT: 6-minute walk test
MI: Myocardial infarction
n.a.: not available

Data Availability

The data associated with the paper are not publicly available, but are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Funding Statement

This research was funded by the Kreiskliniken Reutlingen, Germany.

Authors' contributions

Conception of the work; Coordination and collection of data; Analysis and interpretation of the data; Draft manuscript: K.B. Conception of the work and revision of the manuscript: K.H. All authors have read and approved the final version of the manuscript. All authors declare that they are responsible for all aspects of the work and they will ensure that issues relating to the accuracy of any part of the work are adequately investigated and resolved.

Acknowledgments

The authors would like to acknowledge Nadja Chalamanova for supporting this study as department head.

Supplementary Materials

Supplemetal Digital Content_Kinga Balla.doc

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