Open Access

Journal of Cardiology and Cardiovascular Medicine

Heighten Science PUBLICATIONS Corporation

ISSN 2575-0143

Research Article

Assessment of risk factors and MACE rate among occluded and non-occluded NSTEMI patients undergoing coronary artery angiography: A retrospective cross-sectional study in Multan, Pakistan

Ibtasam Ahmad[1], Muhammad Haris[1], Amnah Javed[1] and Muhammad Azhar[2]*

[1]FMH College of Medicine and Dentistry, Lahore, Pakistan

[2]MBBS, CMH Medical and Dental College, Lahore, Pakistan

***Address for Correspondence:** Muhammad Azhar, MBBS, CMH Medical and Dental College, Lahore, Pakistan, Tel: 092-307-2578263; Fax: 092-62-9255243; Email: dr.azharalvi003@gmail.com

Submitted: 11 May 2018
Approved: 29 May 2018
Published: 30 May 2018

Keywords: Occluded coronary artery; Risk factors; Angiography; Non-ST elevation myocardial infarction; Major adverse cardiovascular event

Abstract

Objectives: The prime focus of the present study was to evaluate the most occluded coronary artery (OCA) among non-ST elevated myocardial infarction (NSTEMI) patients, and risk factors associated with occluded and non-occluded NSTEMI. Also, major adverse cardiovascular event (MACE) were evaluated among patients during index hospitalization.

Methods: A retrospective, cross-sectional study was conducted in Multan Institute of Cardiology, Pakistan between 1st February, 2017, and 31st September, 2017. The data were collected from medical records of the outpatients and inpatients who were index hospitalized. Data were analyzed by using Statistical Packages for Social Sciences (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) And Microsoft Excel (MS Office 2010).

Results: Among 624 patients, angiographic findings revealed that 63.9% were suffering from non-occlusive NSTEMI while 36.1% of the patients had occluded NSTEMI. In occluded NSTEMI patients, 30.3% were having single vessel occlusion while 5.8% were having multi-vessel occlusion. Also, 49.8% were having occlusion of right coronary artery (CA) while 44% were having occluded left anterior descending (LAD) artery. Multivariate analysis revealed that age (p=0.001) and left ventricular ejection fraction (LVEF) (p=0.001) had a statistically significant association. The incidence of MACE was high among non-OCA patients as compared to OCA patients but no statistically significant association was found (p=0.44).

Conclusion: Angiography confirmed that most of the NSTEMI patients had OCA. But the MACE rate was not significantly differ among OCA and non-OCA patients. The risk factors associated with OCA were low LVEF and age.

Introduction

Non-ST elevated myocardial infarction (NSTEMI) is the primary cause of index hospitalization because its symptoms are common among patients suffering from acute coronary syndrome [1,2]. During index hospitalization, coronary angiography is mainly performed to assess the conditions of coronary arteries especially to identify the area of coronary artery which is being blocked or narrowed [3]. Although it is a routine medical practice to perform angiography on both NSTEMI and ST elevated myocardial infarction (STEMI) patients but the timing of this invasive strategy is much delayed for NSTEMI patients as compared to STEMI patients [4]. According to the guidelines

How to cite this article: Ahmad I, Haris M, Javed A, Azhar M . Assessment of risk factors and MACE rate among occluded and non-occluded NSTEMI patients undergoing coronary artery angiography: A retrospective cross-sectional study in Multan, Pakistan. J Cardiol Cardiovasc Med. 2018; 3: 023-030. https://doi.org/10.29328/journal.jccm.1001023

of European Society of Cardiology (ESC), angiography must be performed within < 2 hours of index hospitalization on patients suffering from STEMI and unstable NSTEMI. While those suffering from stable NSTEMI must undergo angiography within 24 or 48 hours of hospitalization [5]. In STEMI patients, emergency angiography is performed prior to angioplasty because one of the major coronary artery (CA) is occluded with thrombus which hinders the flow of blood and enhances the chances of developing necrosis in the tissue[6]. But if the blood flow is restored then many complications associated with STEMI (e.g., size of the infarct) can be lessened [7,8]. It is assumed that either the blood flow is lessened or the transient occlusion has developed in one or more vessels. Also, no favorable evidences are available for emergency angioplasty in patients suffering from NSTEMI [9,10]. These are the reasons due to which the guidelines of American Heart Association (AHA) also don't recommend emergency angioplasty and angiography (within 120 minutes of hospitalization) among stable NSTEMI patients [11].

Although electrocardiography (ECG) is not efficient enough in detecting acute MI (AMI) but in many clinical situations ECG is the foremost diagnostic criteria to differentiate NSTEMI and STEMI [12]. The reports of angiography in previously published literature revealed complete occlusion of CA even in the absence of ST in standard 12-lead ECG [13]. Also, in many cases if there is a delay in angiography and re-vascularization then it negatively effects myocardial function with irreversible loss [14]. There is a limited availability of data on the type of most occluded coronary artery (OCA) in NSTEMI and difference in outcome of patients undergoing angiography [15].

The prime focus of present study was to evaluate the most OCA among NSTEMI patients, risk factors associated with occluded and non-occluded NSTEMI as well as major adverse cardiovascular event (MACE).

Materials and Methods

Study design and setting

A retrospective, cross-sectional study was conducted in Multan Institute of Cardiology, Pakistan. Data were collected between 1st February, 2017, and 31st September, 2017. The selected healthcare setting was a tertiary care public hospital providing comprehensive care to the cardiac patients of all age groups. In this setting there were two angiography labs, where facilities of performing different procedures e.g., diagnostic coronary angiography, pacemaker implantation, right and left cardiac catheterization, and coronary angiography with stent implantation were available.

Study population and sample size

The records of 1,598 patients were scrutinized for the study. Both inpatients and outpatients were included in the study if they were of ≥18 years of age, suffering from NSTEMI, had no history of cardiac revascularization, and underwent angiography for the first time. NSTEMI patients were excluded if they were not going for angiography due to any reason. The records of 624 patients were fulfilled our inclusion criteria and consequently selected for the study.

Data collection

A data collection tool was developed to collect the data. The questionnaire was structured and consisted of five parts: (1) Demographic details and co-morbidities of the patient, (2) Lab test results of cardiac markers (Troponin I and II), (3) Angiographic findings (occluded or non-occluded NSTEMI, single vessel or multi-vessel NSTEMI), (4) type of coronary artery which shows occlusion, and (5) incidence of MACE.

The investigational team included general medical practitioner and a trained nurse. The investigators received the same training prior to the survey for the collection and

validation of data. During the survey, one investigator filled out the investigational form and the other reviewed the data. The expert opinion of an experienced radiologist and histopathologist was taken into account when needed.

If the patient was experiencing NSTEMI signs and symptoms and referred for CA angiography, then such patient was called consecutive patients with recent NSTEMI. Also, those patients who were diagnosed with NSTEMI, during last four weeks, merely on the basis of ECG findings, new left bundle branch blockade (LBBB) and true posterior MI. The record of each patient was assessed only once. If the same patient underwent angiography again, then his record was excluded to avoid duplication. If the stenosis in left main (LM) coronary vessel was 50% and 70% in all other coronary vessels, then this condition was termed as coronary artery disease (CAD). Coronary artery was said to be non-occluded if the stenosis is <30%. But if there was 100% stenosis with thrombolysis in any major coronary vessel, then the condition was termed as OCA.

Due to limitation of data availability, MACE was recorded only among hospitalized patients. If the patient suffered from re-MI, congestive heart failure (CHF), stroke or died during hospitalization then it was termed as MACE.

Data analysis

Continuous variables were presented as mean and standard deviation (SD) while descriptive statistics including frequency and percentages were employed on categorical data. The statistical significant association between continuous variables was found using student's independent t-test and chi-square test. Multivariate logistic regression analysis was used to make comparison between NSTEMI patients undergoing angiography having OCA and non-OCA. The comparison among OCA and non-OCA patients was also made on the basis of MACE by using chi-square test. Data were analyzed by using Statistical Packages for Social Sciences (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) and Microsoft Excel (MS Office 2010).

Ethical approval

Ethical approval was obtained from the Medical Research Ethics Committee (MREC) of Nishtar Medical College, Multan (Reference: 10-2017/REC, dated October 22, 2017). The permission to conduct this study was also obtained from the administrators of the healthcare settings.

Results

Among 624 patients, 71.8% (n=448) were male while 28.2% (n=176) were females. 57.5% (n=359) were suffering from HTN while 40.5% (n=253) were having DM. 22.3% (n=139) were having family history of CAD (Table 1).

Overall 37.3% (n=233) were outpatients while 62.7% (n=391) were inpatients. 52.1% (n=325) patients had multi-vessel CAD and 41.8% (n=261) of them were suffering from single vessel CAD. 63.9% (n=399) were suffering from non-occlusive NSTEMI while 36.1% (n=225) of the patients had occluded NSTEMI. Among the occluded NSTEMI patients, 30.3% (n=189) were having single vessel occlusion while 5.8% (n=36) were having multi-vessel occlusion (Table 2).

Among all the patients suffering from occluded NSTEMI, 49.8% (n=112) were having occlusion of right CA while 44% (n=99) were having occluded LAD (Table 3).

Initially, multivariate logistic regression analysis was applied on age, gender, co-morbidities, and patient's history. Among them age (p=0.001) and left ventricular ejection fraction (LVEF) (p=0.001) showed a statistically significant association. Also revascularization was performed on 50.2% (n=313) of the total inpatients who were index hospitalized. 37.1% (n=116) of patients who underwent revascularization were

Table 1: Characteristics of study population.

Variables		N (%)
Gender	Male	448 (71.8)
	Female	176 (28.2)
Age (years)	18-39	58 (9.3)
	40-59	209 (33.5)
	≥ 60	357 (57.2)
Education	Illiterate	254 (40.7)
	Primary	117 (18.8)
	Secondary	195 (31.3)
	Tertiary	58 (9.3)
Financial status	Employed	119 (19.1)
	Unemployed	347 (55.6)
	Retired	158 (25.3)
Weight	Normal	175 (28.1)
	Underweight	41 (6.6)
	Obese	408 (65.4)
Marital status	Single	68 (10.9)
	Married	254 (40.7)
	Widowed	107 (17.2)
	Divorced	195 (31.3)
Do you smoke cigarettes?	Yes	141 (22.6)
	No	483 (77.4)
Co-morbidities	DM*	253 (40.5)
	HTN†	359 (57.5)
	Dyslipidemia	211 (33.8)

*DM=Diabetes mellitus; †HTN=Hypertension.

Table 2: Diagnosis of study population.

Variables		Total (n=624)	Inpatient (n=391)	Outpatient (n=233)
CAD*	Non-obstructive	38 (6.1)	12 (3.1)	26 (11.2)
	Single vessel	261 (41.8)	137 (35.0)	124 (53.2)
	Multiple vessel	325 (52.1)	242 (61.9)	83 (35.6)
NSTEMI†	Non-occluded	399 (63.9)	249 (63.7)	150 (64.4)
	Occluded	225 (36.1)	142 (36.3)	83 (35.6)
	Single vessel occlusion	189 (30.3)	131 (33.5)	58 (24.9)
	Multi-vessel occlusion	36 (5.8)	12 (3.1)	24 (10.3)

*CAD=Coronary artery disease; †NSTEMI=Non-ST elevation myocardial infarction.

Table 3: Occluded coronary vessels among NSTEMI patients.

OCA* (n=225)	N (%)
Left main	3 (1.3)
Circumflex, OM†	74 (32.9)
Ramus Intermedius	8 (3.6)
Right CA‡	112 (49.8)
LAD§	99 (44.0)

*OCA=Occluded coronary artery; †OM=Obtuse Marginal; ‡CA=Coronary artery; §LAD=Left Anterior Descending artery.

having OCA while 62.9% (n=197) were suffering from non-OCA. But their difference was not statistically significant. The mode of revascularization between OCA and non-OCA groups was different. 24% (n=54) patients in OCA group underwent CABG while in non-OCA CABG was performed on 10.8% (n=43) of the patients. Also, 38.6% (n=154) of non-OCA patients undertook PCI while only 27.6% (n=62) of the OCA patients were underwent PCI (Table 4).

4.6% (n=18) of the NSTEMI patients experienced MACE during index hospitalization. While only 2.6% (n=10) died. The incidence of MACE was high among non-OCA patients as compared to OCA patients but no statistically significant association was found (p=0.44) (Table 5).

Discussion

The diagnosis of coronary artery occlusion via angiography among patients suffering from NSTEMI is not occasional. In the present study angiographic findings

Table 4: Multivariate logistic regression analysis.

Characteristics		Total patients N=624	NSTEMI* patients undergoing coronary angiography		p-value
			Any Occluded coronary artery N=225	Non occluded coronary artery N=399	
			SD±Mean	SD±Mean	
Age (years)		56.4 ± 12.2	58.2 ±11.3	54.5 ±14.7	0.001
Peak Trop I levels (ng/mL)		13.4 ± 37.3	16.1 ±39.5	17.2± 29.4	0.16
LVEF† (%)		42.5 ± 9.9	44.4 ±8.6	49.3± 11.6	0.001
			N (%)	N (%)	
Gender	Male	448 (71.8)	123 (54.7)	325 (81.5)	0.01
	Female	176 (28.2)	102 (45.3)	74 (18.5)	0.01
Co-morbidities	DM‡	253 (40.5)	134 (59.6)	119 (29.8)	0.007
	HTN§	359 (57.5)	148 (65.8)	211 (52.9)	0.06
	Dyslipidemia	211 (33.8)	82 (36.4)	129 (32.3)	0.31
Smoking	Current smokers	141 (22.6)	46 (20.4)	95 (23.8)	0.87
History	Positive family history of premature CAD‖	139 (22.3)	55 (24.4)	84 (21.1)	0.31
	History of Prior MI¶	123 (19.7)	61 (27.1)	62 (15.5)	0.007
	Prior PCI**	55 (8.8)	24 (10.7)	31 (7.8)	0.21
Revascularization		313 (50.2)	116 (51.6)	197 (49.4)	0.32
CABG††		97 (15.6)	54 (24.0)	43 (10.8)	<0.001
PCI		216 (34.6)	62 (27.6)	154 (38.6)	<0.001

*NSTEMI=Non-ST elevated myocardial infarction; †LVEF=Left ventricular ejection fraction; ‡DM=Diabetes mellitus; §HTN=Hypertension; ‖CAD=Coronary artery disease; ¶MI=Myocardial infarction; **PCI= percutaneous coronary intervention; ††CABG= Coronary artery bypass grafting.

Table 5: MACE incidence among NSTEMI in-patients during index hospitalization.

Events	Total NSTEMI* inpatients (n=391)	NSTEMI with occluded (n=142)	NSTEMI with non-occluded (n=249)	p-value
In hospital MACE† (composite)	18 (4.6)	7 (4.9)	11 (4.4)	0.44
Death‡	10 (2.6)	4 (2.8)	6 (2.4)	0.20
Re-infarction	5 (1.3)	2 (1.4)	3 (1.2)	0.13
Stroke	0	0	0	--
Heart failure	3 (0.8)	1 (0.7)	2 (0.8)	0.05

*NSTEMI=Non-ST elevated myocardial infarction; †MACE= Major adverse cardiovascular event; ‡Deaths caused by stroke and myocardial infarction.

confirmed that 36.1% NSTEMI patients had occluded coronary artery. The frequency of all the occlusions in coronary arteries were fairly uniform. The clinical outcomes of hospitalized NSTEMI patients were not significantly differ from those who had coronary artery occlusion. Also, advancement in age and low LVEF were among the predictors of coronary artery occlusion among NSTEMI patients. The findings of present study are in line with the previously published literature. A study conducted in USA on patients undergoing percutaneous coronary intervention (PCI) revealed that 24% of the NSTEMI patients had occluded coronary artery [15]. Furthermore, a single occluded culprit artery was found per NSTEMI patient. There are variations in findings among different studies because of the difference in criteria of patient selection. This is the reason that in a study the frequency of coronary artery occlusion was found to be 29% [16] while in another study it was found to be 63% [17]. The incidence of coronary artery occlusion was high in this study. This might be because of the fact that many patients hesitate to visit medical facilities due to financial constraints and poor diagnostic facilities. These reasons contribute towards the late detection of ischemic heart diseases. In STEMI patients LAD is the most commonly occluded vessel. But no such predominance of artery with respect to occlusion has reported in NSTEMI. Also, studies concluded LCX occlusion in many cases of NSTEMI [18,19]. Another study revealed occlusion of posterolateral vessels in NSTEMI because of late diagnosis of posterior infarct [13]. While in a study there was uniform distribution of occluded coronary vessels found [15]. In this study LCX occlusion was not commonly found because ECG of those patients was performed regularly who showed precordial ST-T changes.

The risk factors associated with coronary artery occlusion among NSTEMI patients were found to be advancement in age, co-morbidities (e.g., diabetes), gender and low LVEF. These findings are in line with a previously published study [13]. Most of them, excluding age and LVEF, were found to have non-significant association in the multivariate regression analysis. Hence, further investigation is needed for exploring these contradictory results.

Furthermore, a study revealed that mortality rate of NSTEMI patients were high among those who had OCA as compared to non-OCA patients [20]. Although no follow up was performed in this study, but in both groups there was no statistical difference found with respect to MACE rates. The rate of mortality was found to be similar among both OCA and non-OCA groups. In contrast to our finding, the previously published studies revealed that the death rate was found to be higher among OCA patients as compared to non-OCA [20,21].

The clinical signs and symptoms of NSTEMI patients varies with the angiographic judgements. But our findings can be beneficial for those NSTEMI patients who undergo angiographic examination during the earlier stage of CAD. These can also be applied to those who are at risk of developing OCA, have CHF, low LVEF, and left ventricular (LV) pump dysfunctioning. For providing better facilities to the patients, it is recommended that non-invasive diagnostic facilities must be provided to those who are suspected to CAD. These facilities may include 80-lead body surface potential mapping (BSPM) [22] and transthoracic echo for LV function, Coronary computed tomography (CT) angiogram or strain rate echocardiography [23].

Like other studies, the present study also have some limitations. First, it is single center study conducted on a very small number of patients for a short duration of time. Second, the study is confined to those patients who underwent angiography but didn't evaluate the reasons which hinder NSTEMI patients from angiography. It might be possible that therapeutic management is more preferred than angiography for patients having low risk of NSTEMI. Furthermore, elderly patients and renal impaired patients are not allowed to go through this procedure. Thus, this biasness in the selection of patients can negatively effects the interpretation of findings. Third, most of the records were of patients who came to OPDs and it might be possible that among them acute events had passed earlier. Thus, the angiographic findings couldn't be well interpreted because in these patients therapeutic regimen recanalized the coronary lesions. Fourth, the study included those patients who had history of MI, so silent MI could be the cause of OCA on angiogram. Thus, longitudinal prospective studies are requisite to overcome these issues.

Conclusion

It is concluded that most of the NSTEMI patients undergoing angiography were diagnosed with OCA. No vessel was found to be most occluded among majority of the cases. The MACE rate was not significantly differ among OCA and non-OCA patients. The risk factors associated with OCA were low LVEF and age. Longitudinal prospective studies in the future are requisite for elaborating this relationship.

Acknowledgement

We would like to appreciate the help from the hospital staff for their help in data retrieving.

References

1. Ruff, CT and Braunwald E, The evolving epidemiology of acute coronary syndromes. Nat Rev Cardiol. 2011; 8: 140-147. **Ref.:** https://goo.gl/9y6krt

2. Yeh RW, Sidney S, Chandra M, Sorel M, Selby JV, et al. Population trends in the incidence and outcomes of acute myocardial infarction. N Engl J Med. 2010; 362: 2155-2165. **Ref.:** https://goo.gl/hFmFjo

3. Roe MT, White JA, Kaul P, Tricoci P, Lokhnygina Y, et al., Regional patterns of use of a medical management strategy for patients with non–ST-segment elevation acute coronary syndromes: insights from the EARLY ACS Trial. Circ Cardiovasc Qual Outcomes. 2012; 5: 205-213. **Ref.:** https://goo.gl/6A1VD1

4. Katritsis DG, Siontis GC, Kastrati A, van't Hof AW, Neumann FJ, et al. Optimal timing of coronary angiography and potential intervention in non-ST-elevation acute coronary syndromes. Eur Heart J. 2011; 32: 32-40. **Ref.:** https://goo.gl/ZJu6zk

5. Warnica JW, Acute Myocardial Infarction (MI). MSD Mannual. 2016. **Ref.:** https://goo.gl/MfiqST

6. Bonow O, Mann D, Zipes D, Libby P. Braunwald's Heart Disease E-Book: A Textbook of Cardiovascular Medicine. 2011. **Ref.:** https://goo.gl/t4saoZ

7. Francone M, Bucciarelli-Ducci C, Carbone I, Canali E, Scardala R, et al. Impact of Primary Coronary Angioplasty Delay on Myocardial Salvage, Infarct Size and Microvascular Damage in Patients with ST-Elevation Myocardial Infarction: Insight from Cardiovascular Magnetic Resonance. J Am Coll Cardiol. 2009; 54: 2145-2153. **Ref.:** https://goo.gl/rN4jaH

8. Brodie BR, Stone GW, Cox DA, Stuckey TD, Turco M, et al. Impact of treatment delays on outcomes of primary percutaneous coronary intervention for acute myocardial infarction: analysis from the CADILLAC trial. Am Heart J. 2006; 151: 1231-1238. **Ref.:** https://goo.gl/EUKi3f

9. Navarese SEP, Servi De C, Gibson AM, Buffon F, Castriota J, et al. Early vs. delayed invasive strategy in patients with acute coronary syndromes without ST-segment elevation: a meta-analysis of randomized studies. QJM: An Int J Med. 2011; 104: 193-200. **Ref.:** https://goo.gl/Lg4ASj

10. Riezebos RK. Percutaneous coronary intervention for non ST-elevation acute coronary syndromes: which, when and how? American Journal of Cardiology. 2011; 107: 509-515.

11. Casey DE, Jneid H, Anderson JL, Wright RS, Adams CD, et al. 2012 ACCF/AHA Focused Update of the Guideline for the Management of Patients With Unstable Angina/Non–ST-Elevation Myocardial Infarction (Updating the 2007 Guideline and Replacing the 2011 Focused Update). J Am Coll Cardiol. 2012; 60: 645-681. **Ref.:** https://goo.gl/pwtCpZ

12. McClelland AJ, Owens CG, Menown IB, Lown M, Adgey AA. Comparison of value of leads from body surface maps to 12-lead electrocardiogram for diagnosis of acute myocardial infarction. Am J Cardiol. 2003; 92: 252-257. **Ref.:** https://goo.gl/YgpJF5

13. Wang TY, Zhang M, Fu Y, Armstrong PW, Newby LK, et al. Incidence, distribution, and prognostic impact of occluded culprit arteries among patients with non-ST-elevation acute coronary syndromes undergoing diagnostic angiography. Am Heart J. 2009; 157: 716-723. **Ref.:** https://goo.gl/hJAp95

14. Grenne B, Eek C, Sjøli B, Skulstad H, Aakhus S, et al. Changes of myocardial function in patients with non-ST-elevation acute coronary syndrome awaiting coronary angiography. American Journal of Cardiology. 2010; 105: 1212-1218. **Ref.:** https://goo.gl/Rqe2tA

15. Dixon WC, Wang TY, Dai D, Shunk KA, Peterson ED, et al. Anatomic distribution of the culprit lesion in patients with non–ST-segment elevation myocardial infarction undergoing percutaneous coronary intervention: findings from the National Cardiovascular Data Registry. J Am Coll Cardiol. 2008; 52: 1347-1348. **Ref.:** https://goo.gl/p9p9sZ

16. Bahrmann P, Rach J, Desch S, Schuler GC, Thiele H. Incidence and distribution of occluded culprit arteries and impact of coronary collaterals on outcome in patients with non-ST-segment elevation myocardial infarction and early invasive treatment strategy. Clinical Research in Cardiology, 2011; 100: 457-467. **Ref.:** https://goo.gl/GuKJYG

17. Koyama, Y., et al., Prevalence of coronary occlusion and outcome of an immediate invasive strategy in suspected acute myocardial infarction with and without ST-segment elevation. American Journal of Cardiology. 2002; 90: 579-584.

18. Abbas AE , Boura JA , Brewington SD , Dixon SR , O'Neill WW, et al. Acute angiographic analysis of non–ST-segment elevation acute myocardial infarction. American Journal of Cardiology. 2004; 94: 907-909. **Ref.:** https://goo.gl/wWNoMn

19. Rasoul S, de Boer MJ, Suryapranata H, Hoorntje JCA, Gosselink ATM, et al. Circumflex artery-related acute myocardial infarction: limited ECG abnormalities but poor outcome. Neth Heart J. 2007; 15: 286-290. **Ref.:** https://goo.gl/Tu8Jb7

20. Kim MC, Ahn Y, Rhew SH, Jeong HM, Kim JH, et al., Impact of total occlusion of an infarct-related artery on long-term mortality in acute non-ST-elevation myocardial infarction patients who underwent early percutaneous coronary intervention. International heart journal. 2012; 53: 160-164. **Ref.:** https://goo.gl/JWBYsK

21. Song YB , Hahn JY , Kim JH , Lee SY , Choi SH , et al., Comparison of angiographic and other findings and mortality in non–ST-segment elevation versus ST-segment elevation myocardial infarction in patients undergoing early invasive intervention. American Journal of Cardiology. 2010; 106: 1397-1403. **Ref.:** https://goo.gl/UU9s8S

22. Daly MJ, Finlay DD, Guldenring D, Nugent CD, Tomlin A, et al., Detection of acute coronary occlusion in patients with acute coronary syndromes presenting with isolated ST-segment depression. Eur Heart J Acute Cardiovasc Care. 2012; 1:128-135. **Ref.:** https://goo.gl/vpUooY

23. Grenne B, Eek C, Sjøli B, Dahlslett T, Uchto M, et al. Acute coronary occlusion in non-ST-elevation acute coronary syndrome: outcome and early identification by strain echocardiography. Heart. 2010; 96: 1550-1556. **Ref.:** https://goo.gl/LxWosQ