ORIGINAL ARTICLE

Frequency and distribution of angiographically occluded coronary artery and in-hospital outcome of patients with Non ST elevation myocardial infarction

Saba Aijaz, Bashir Hanif

Abstract

Objective: To calculate the frequency and distribution of occluded coronary artery in patients with recent non-ST elevation myocardial infarction undergoing coronary angiography, and to compare major adverse cardiovascular events during hospitalisation with patients suffering from non-occluded coronary artery.

Methods: The cross-sectional analytical study was conducted at Tabba Heart Institute, Karachi, from July2013 to March 2014. Patients of both gender and all ages undergoing angiography with non-ST elevation myocardial infarction were included. Data on patient demographics, angiographic findings and in-hospital complications was collected. Frequency of occluded vessels and their distribution was reported. Multivariate logistic regression modelling was used to examine variables associated with an occluded coronary artery in non-ST elevation myocardial infarction. Major adverse cardiovascular events were compared between patients of occluded and non-occluded coronary aetery. A two sided p-value of < 0.05 was taken as significant.

Results: In 703 patients studied, occluded coronary artery was present in 277(39%). Predictors of having an occluded coronary artery were increasing age (57.6±11.2 vs. 60.0±10.0; p: 0.03) and low left ventricular ejection fraction (43.9±12.2 vs. 50.1±10.1; p: 0.000). There was no significant difference in terms of major adverse cardiovascular events in patients with occluded and non-occluded coronary arteries (Hazard Ratio: 0.53, 95% confidence interval: 0.14-1.98; p=0.33).

Conclusion: Totally occluded coronary vessel is a frequent finding in non-ST elevation myocardial infarction, highlighting the need for angiography and re-vascularisation to salvage at-risk myocardium in selected patients.

Keywords: Non-ST elevation myocardial infarction, NSTEMI, Occluded coronary artery, Major adverse cardiovascular events, MACE. (JPMA 66: 504; 2016)

Introduction

Non-ST elevation myocardial infarction (NSTEMI) is the most common presentation of acute coronary syndrome and a leading cause of hospital admissions.[1,2] Many patients with a diagnosis of NSTEMI get a coronary angiography done during the index hospitalisation through early invasive strategy.[3] Timing of angiography is, however, much delayed compared to those with ST elevation MI(STEMI).[4] The rationale behind emergency angiography with the intent of doing angioplasty in STEMI is that blood flow in one of the major coronary artery is acutely disrupted due to vessel occlusion by a thrombus and the downstream myocardial tissue is at risk of necrosis unless the flow in the involved vessel is restored.[5] Earlier the flow is restored, the more are the chances of reducing the infarct size and related complications of STEMI.[6,7] In NSTEMI it is believed that either one or more vessel is transiently occluded or that the blood flow is critically reduced in a patent vessel i.e. subtotal occlusion. In addition there is lack of supportive evidence in favour of emergency angioplasty in patients with NSTEMI.[8,9] For these reasons, doing emergent angiography and angioplasty is not mandatory in all patients with NSTEMI, according to current American Heart Association (AHA) guidelines.[10]

In clinical practice, electrocardiogram (ECG) criteria is used to differentiate STEMI from NSTEMI, but ECG has been shown to have a very low sensitivity in detecting acute MI (AMI)[11] and thus occlusion of a coronary vessel. It has been shown in various studies that in NSTEMI, angiography may reveal totally occluded coronary arteries (OCAs), further reinforcing that coronary artery occlusion can occur despite the absence of ST elevation in standard 12-lead ECG.[12] Studies have shown that in patients with NSTEMI, myocardial function deteriorates and the damage becomes irreversible as the time to angiography and re-vascularisation increases, especially in those who have occluded coronaries on angiogram.[13] There is limited data on frequency and distribution of occluded coronary vessels in NSTEMI[14] and whether there is any difference in outcome of NSTEMI patients with OCA on angiography compared to those NSTEMI patients with non-OCA.

Department of Cardiology, Tabba Heart Institute, Karachi, Pakistan.
Correspondence: Saba Aijaz. Email: sabaxlent@gmail.com

The current study was planned to estimate the frequency and distribution of OCA in patients with recent NSTEMI. Also, we planned to explore in-hospital outcomes of patients admitted with NSTEMI based on their angiographic findings of occluded vs. non-occluded vessels.

Patients and Methods

The analytical cross-sectional study was done at Tabba Heart Institute, Karachi, and comprised records of consecutive patients coming for coronary angiography between July 1, 2013, and March 31, 2014, after ethical approval was obtained from the institutional review board.

Consecutive patients with recent NSTEMI were defined as NSTEMI within the preceding four weeks referred for coronary angiography. NSTEMI by definition excluded patients with ECG findings of ST segment elevation, new or presumed new left bundle branch block (LBBB) and true posterior MI within four weeks. Assessment of Q waves on ECG is not routinely recorded in the data registry. Both inpatients and outpatients were included. Patients of both genders and all age groups were included. Patients with prior coronary artery bypass grafting (CABG) were excluded. NSTEMI inpatients not undergoing angiography for any reason were also excluded. In case of patients with repeated procedures during the study period, only first procedure was counted to avoid duplication. Data for all the variables was derived from acute coronary syndrome (ACS) and Cath Percutaneous Coronary Intervention(PCI) registry, based on National Cardiovascular Data Registry(NCDR) Cath PCI registry format that is routinely maintained at the institute for data collection about all patients with ACS since 2012. Demographic data, including age, gender, diabetes mellitus, hypertension, family history of premature coronary artery disease (CAD), dyslipidaemia, prior known MI, smoking status and troponin I levels, was recorded. Percent left ventricular ejection fraction (LVEF) was also recorded. Angiographic findings, including dominance (left, right or co-dominant), numbers and types of coronary vessels involved, including left main (LM), left anterior descending (LAD) artery, left circumflex (LCX), Ramus Intermedius (RI) and right coronary artery (RCA), were retrieved. Based on the percent stenosis, LM with more than 50% stenosis (obstruction) and all other vessels with more than 70% stenosis were counted as significant CAD, while any vessel with less than 30% stenosis was counted as non-obstructive coronary artery. An OCA was defined as presence of a lesion with 100% stenosis or thrombolysis in myocardial infarction (TIMI) flow grade 0 to 1 in one or more major coronary vessels on invasive coronary angiography. Major branch occlusion was incorporated in the major vessel territory.

For admitted NSTEMI patients with index hospitalisation, in-hospital events data (re- infarct, heart failure or stroke) was retrieved. Vital status at discharge was also recorded. A major adverse cardiovascular event (MACE) was defined as composite of death, re-myocardial infarction, heart failure and stroke during hospital stay.

SPSS 17was used for statistical analysis. Mean values and standard deviations were calculated for continuous variables, and frequencies and percentages were calculated for categorical variables. Continuous variables were included as such if they had a normal distribution checked through histogram and Q-Q plot. Frequency of occluded vessels and their distribution in NSTEMI patients were reported as frequencies and percentages. Clinical characteristics and re-vascularisation outcomes were compared between occluded and non- occluded coronary artery groups. Continuous variables were compared using student's independent t-test, whereas nominal categorical variables were compared using Chi square test.

Multivariate logistic regression modelling was used to examine the relation between predictor variables and an occluded coronary artery in NSTEMI patients and also to assess possible confounding and interaction. Variable found to be statistically significant in univariate analysis, or those which were clinically relevant, were included in the model.

MACE was compared between occluded and non-occluded coronary arteries and significance was tested using chi square test. A two sided p-value of 0.05 was taken as significant. Also, 95% confidence intervals (CI) were calculated for the outcome measures wherever indicated.

Results

During the study period, 2409 cases had been entered in the registry. A total of 703(29.2%) patients were included in the study. Of them, 299(43%) were outpatients and 404(57%) were inpatients. Overall, 70(10%) patients had non-obstructive CAD, 213(30%) had single-vessel CAD, and 420(60%) had multi-vessel coronary involvement. The frequency of one or more occluded coronary artery i.e. 100% stenosis among all NSTEMI patients undergoing coronary angiography was 277(39%), while the remaining 426(60.6%) were non-OCA (Table-1). Significant obstructive CAD in multiple vessels was more common in the occluded group (n=36; 13%) compared to non-occluded (n=21; 15%) ($p<0.001$).Of the OCA patients, 202(73%) had single-vessel occlusion and 75(27%) had more than one occluded coronary artery.

Table-1: Patients characteristics.

	NSTEMI undergoing coronary angiography. N=703 (percentage)	Subgroups		p-value
		Any Occluded coronary artery N=277 (percentage)	Non occluded coronary artery N=426 (percentage)	
Age (years)	58.6 ± 10.8	60.0 ±10.0	57.6 ±11.2	0.003
Gender (male)	565 (80.4)	235 (84.8)	330 (77.4)	0.01
Diabetes mellitus	379 (53.9)	167 (60.2)	212 (49.8)	0.006
Hypertension	459 (65.3)	192 (69.3)	267 (62.7)	0.07
Dyslipidaemia	237 (33.7)	100 (36.1)	137 (32.2)	0.28
Current smokers	150 (21.3)	59 (21.3)	91 (21.4)	0.98
Positive family history of premature CAD	156 (22.2)	55 (19.8)	101 (23.7)	0.23
History of Prior MI	160 (22.8)	78 (28.2)	82 (19.2)	0.006
Prior PCI	67 (9.5)	31 (11.1)	36 (8.4)	0.23
Peak Trop I levels ng/mL	15.7 ± 34.7	18.2 ±37.2	14.0± 33.0	0.15
LV Ejection fraction (%)	47.7 ± 11.4	43.9 ±12.2	50.1± 10.1	?0.001

NSTEMI: Non-ST elevation myocardial infarction
CAD: Coronary artery disease
MI: Myocardial infarction
PCI: Percutaneous coronary intervention.

Table-2: Distribution and frequency of occluded coronary arteries in NSTEMI.

Occluded Coronary artery, N=277	Number	*Frequency (%)
Left main	2	0.7
LAD	121	43.7
Circumflex, OM	106	38.3
Right CA	132	47.6
Ramus Intermedius	5	1.8

NSTEMI: Non-ST elevation myocardial infarction
LM: Left main
LAD: Left anterior descending artery
LCX: Left circumflex
RCA: Right coronary artery
*Please note that the frequencies do not add up to 100% as more than one vessel were occluded in about 10.7% patients.

Table-3: Comparison of in-hospital adverse events in patients with index hospitalisation.

Events	NSTEMI with Occluded CADN=154 (%)	NSTEMI with Non- Occluded CAD, N=249 (%)	p-value
In hospital MACE (composite)	4 (2.5)	9 (3.6)	0.33
Death	2 (1.2)	7 (2.8)	0.31
Re-infarction	0 (0)	2 (0.8)	0.26
Heart failure	2 (1.2)	0 (0)	0.07
Stroke	0	0	NA

NSTEMI: Non-ST elevation myocardial infarction
CAD: Coronary artery disease
MACE: Major adverse cardiovascular events.

The distribution of occlusion was also noted (Table-2).

Re-vascularisation using PCI or CABG during index hospitalisation was done in 334(47.5%) patients' 125(37.4%) from the OCA group and 209(62.5%) from the non-OCA group. This difference was not statistically significant. (odds ratio [OR]: 0.85; 95% confidence interval [CI]: 0.60-1.16; p=0.30). However, mode of re-vascularisation was different between the two groups. More patients underwent CABG in OCA group (n=66; 24%) compared to non-OCA (n=40; 9.4%)(OR: 3.0;95% CI: 1.97-4.62; p<0.001).PCI was more common in non-OCA patients (n= 170; 40%)compared to OCA (n=60; 39.9%) (OR: 2.4; 95% CI: 1.70-3.39; p<0.001).

For multivariate logistic regression model, variables initially entered included age, gender, having diabetes or hypertension, history of prior MI, LVEF and troponin levels. However, in the final model, only two variables were found to have statistical significance. These included increasing age (57.6 ±11.2 vs. 60.0 ±10.0; p=0.03) and low LVEF (43.9 ±12.2 vs. 50.1± 10.1; p<0.001). However, there was no meaningful clinical significance due to very small OR values.

Total in-hospital MACE rate was 13(3.2%) and in-hospital mortality was 9(2.2%) (Table-3). MACE rate was somewhat higher among non-OCA group, but it was not statistically significant (3.6% vs. 2.5%; Hazard Ratio: 0.53; 95% CI: 0.14-1.98; p=0.33).

Discussion

Having an occluded coronary vessel on an angiogram in patients with NSTEMI is not infrequent. The current study has shown that around 39% of the NSTEMI patients who underwent angiography had coronary occlusion. Also, the occlusion was fairly uniformly distributed among all the three major coronary vessel branches. There was no significant difference in the clinical outcome of patients during hospital stay in relation to having an OCA in our study. Important predictors of having an OCA in NSTEMI patients included increased age and low LVEF.

Our findings correlate in many aspects with prior data. In one study done in the USA this frequency was around 24%[14] but the study population was restricted only to patients undergoing PCI. Also, a single occluded culprit was identified per patient. Further studies have shown variable findings and, depending upon the difference in patient selection, the percentage of occluded coronaries was found to be around 29%[15] to 63%.[16] The reason for having higher OCA prevalence in our study might be late presentation of patients to a medical facility, prior undetected MI, or missed STEMI due to lack of early identification of ischaemic heart disease in a developing world setup. The distribution of OCA was heterogeneous with no predominance of any particular major coronary vessel unlike that of STEMI where LAD is usually the most common culprit. A few studies have shown a predominance of LCX occlusion[17,18] or postero-lateral vessels being more common than LAD in NSTEMI likely due to missed posterior infarct,[12] while one study has shown uniform distribution of occluded vessels.[14] In our setup, due to routine use of posterior ECG in emergency room in patients with precordial ST-T changes, LCX occlusion may not have predominated.

As in an earlier study, important predictors in initial analysis in our study included male gender, higher age, having diabetes and low LVEF.[12] Most of these, except age and LVEF, were found to be non-significant in the adjusted model.

Most of the studies have shown increased in-hospital short- and long-term mortality in NSTEMI with OCA compared to non-OCA CAD.[19] Though our study did not have any long-term follow-up, but in-hospital MACE rates were not statistically different between the two groups. Mortality rate is also quite similar in the two groups; absolute rate being on the lower side compared to prior studies of overall in-hospital mortality in NSTEMI and in relation to having occluded vessels.[20,21]

The NSTEMI population is quite heterogeneous both in relation to clinical presentation and angiographic findings. Despite this fact, the results of our study can be applicable to the population of NSTEMI patients with high-risk features in whom early invasive strategy (coronary angiography in addition to medical treatment) is planned from the start. Especially in patients with high risk of coronary occlusion, such as those found to have a low LVEF, clinical heart failure, implied LV pump failure, and increased age, emergent angiography as in STEMI with intent of doing early re-vascularisation can be a viable option to salvage the compromised myocardium.

Use of non-invasive tests in the emergency room as an adjunct to traditional tools for diagnosing MI may be helpful in making decisions in selected high-risk ACS patients. These 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]

There are certain limitations to our study that should be kept in mind while interpreting the results. The study was done at a single centre, and about half of the patients with NSTEMI had not undergone coronary angiogram due to several reasons that were beyond the scope of the study. Reasons for conservative management plan could have been multiple. Either those patients were low-risk NSTEMI, thus managed medically (more likelihood of having non-obstructed and non-occluded coronaries); or they might have been very high-risk for coronary angiogram due to high-risk profile such as extreme age or renal failure (more likely to have multi-vessel obstruction and occlusion). This inherent selection bias can have an effect in both directions. About half of the patients with NSTEMI were outpatients in whom acute event had passed earlier. This might affect the angiographic findings in the sense that coronary lesions might have become re-canalised with initial medical therapy. This will undermine the frequency of occlusion in NSTEMI population. Patients with known prior MI were included in the study so caution should be exercised in interpreting the results. There might have been patients with old, silent MI that can cause an occluded coronary vessel on angiogram. This may further overestimate the frequency of occluded CAD in our NSTEMI patients. More extensive ECG analysis for presence or absence of Q waves would have been more helpful in this differentiation.

Conclusion

More than one-third of patients undergoing coronary angiography for NSTEMI had one or more OCA. Probability of having an occlusion was equally distributed among all major coronary artery branches with no clear predominance for any one vessel. There was no difference between the groups in terms of in-hospital MACE. Major predictors of having an occluded vessel were age of the patient and LVEF. Further studies with better study design are needed to elaborate this relationship.

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References

1. Ruff CT, Braunwald E. The evolving epidemiology of acute coronary syndromes. Nature Rev Cardiol 2011; 8: 140-7.
2. Yeh RW, Sidney S, Chandra M, Sorel M, Selby JV, Go AS. Population trends in the incidence and outcomes of acute myocardial infarction. N Engl J Med 2010; 362: 2155-65.
3. Roe MT, White JA, Kaul P, Tricoci P, Lokhnygina Y, Miller CD, 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: 205-13.
4. Katritsis DG, Siontis GC, Kastrati A, van't Hof AW, Neumann FJ, Siontis KC, et al. Optimal timing of coronary angiography and potential intervention in non-ST-elevation acute coronary syndromes. Eur Heart J 2011; 32: 32-40.
5. Antman EM. Braunwald's Heart Disease. In: Robert O. Bonow M, Mann DL, Zipes DP, Libby P. A Textbook of Cardiovascular Medicine. 9th ed. Phelidelphia: Elsevier Inc; 2012.
6. Francone M, Bucciarelli-Ducci C, Carbone I, Canali E, Scardala R, Calabrese FA, et al. Impact of Primary Coronary Angioplasty Delay on Myocardial Salvage, Infarct Size, and Microvascular Damage in Patients With ST-Segment Elevation Myocardial InfarctionInsight From Cardiovascular Magnetic Resonance. J Am Coll Cardiol 2009; 55: 2145-53.
7. Brodie BR, Stone GW, Cox DA, Stuckey TD, Turco M, Tcheng JE, 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: 1231-8.
8. Navarese E, De Servi S, Gibson CM, Buffon A, Castriota F, Kubica 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 2011; 104: 193-200.
9. Riezebos RK, Tijssen JG, Verheugt FW, Laarman GJ. Percutaneous coronary intervention for non ST-elevation acute coronary syndromes: which, when and how? Am J Cardiol 2011; 107: 509-15.
10. Jneid H, Anderson JL, Wright RS, Adams CD, Bridges CR, Casey DE, 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) A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2012; 60: 645-81.
11. Owens C, McClelland A, Walsh S, Smith B, Adgey J. Comparison of value of leads from body surface maps to 12-lead electrocardiogram for diagnosis of acute myocardial infarction. Am J Cardiol 2008; 102: 257-65.
12. Wang TY, Zhang M, Fu Y, Armstrong PW, Newby LK, Gibson CM, 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: 716-23.
13. Grenne B, Eek C, Sjøli B, Skulstad H, Aakhus S, Smiseth OA, et al. Changes of myocardial function in patients with non-ST-elevation acute coronary syndrome awaiting coronary angiography. Am J Cardiol 2010; 105: 1212-8.
14. Dixon WC, Wang TY, Dai D, Shunk KA, Peterson ED, Roe MT. Anatomic Distribution of the Culprit Lesion in Patients With Non ST-Segment Elevation Myocardial Infarction Undergoing Percutaneous Coronary InterventionFindings From the National Cardiovascular Data Registry. J Am Coll Cardiol 2008; 52: 1347-8.
15. 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. Clin Res Cardiol 2011; 100: 457-67.
16. Koyama Y, Hansen PS, Hanratty CG, Nelson GIC, Rasmussen HH. Prevalence of coronary occlusion and outcome of an immediate invasive strategy in suspected acute myocardial infarction with and without ST-segment elevation. Am J Cardiol 2002; 90: 579-84.
17. Abbas AE, Boura JA, Brewington SD, Dixon SR, O'Neill WW, Grines CL. Acute angiographic analysis of non-ST-segment elevation acute myocardial infarction. Am J Cardiol 2004; 94: 907-9.
18. Rasoul S, de Boer MJ, Suryapranata H, Hoorntje JC, Gosselink AM, Zijlstra F, et al. Circumflex artery-related acute myocardial infarction: limited ECG abnormalities but poor outcome. Neth Heart J 2007; 15: 286-90.
19. Kim MC, Ahn Y, Rhew SH, Jeong MH, Kim JH, Hong YJ, 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. Int Heart J 2011; 53: 160-4.
20. Song YB, Hahn JY, Kim JH, Lee SY, Choi SH, Choi JH, 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. Am J Cardiol 2010; 106: 1397-403.
21. Kim MC, Ahn Y, Rhew SH, Jeong MH, Kim JH, Hong YJ, 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.Int Heart J 2012; 53: 160-4.
22. Daly M, Finlay D, Guldenring D, Nugent C, Tomlin A, Smith B, 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: 128-35.
23. Grenne B, Eek C, Sjøli B, Dahlslett T, Uchto M, Hol PK, et al. Acute coronary occlusion in non-ST-elevation acute coronary syndrome: outcome and early identification by strain echocardiography. Heart 2010; 96: 1550-6.