

Influence of Presenting Electrocardiographic Findings on the angiographic outcome, in-hospital morbidity and mortality in patients with non-ST segment elevation myocardial infarction

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Abstract

Background: the role of presenting ECG in patients with non –ST segment elevation myocardial infarction as a tool of risk stratification and a predictor of angiographic outcome, in hospital morbidity and mortality has not been well studied in contemporary practice. **Methods:** This is a prospective, observational, non-controlled study included four hundred patients with NSTEMI admitted at National Heart Institute from August 2014 to march 2015 and the patients were classified into 4 groups according to ECG findings: patients with ST depression, patients with T wave inversion, patients with transient ST elevation and patients with normal ECG findings, 100 patient in each group of patients. all patients were subjected to demographic data analysis, clinical examination, ECG, echocardiography, coronary angiography. All patients received proper medications and proper method of revascularization with follow up of morbidity and mortality during hospital stay. **Results:** Patients presenting with ST-segment depression were the oldest and had the greatest prevalence of major cardiac risk factors Angiogram revealed that patients with ST-segment depression had more left main ,proximal left anterior descending, and 3-vessel coronary artery disease and underwent coronary artery bypass grafting most often. In contrast, patients with transient ST-segment elevation had 1-vessel CAD and underwent percutaneous coronary intervention the most. No ischemic changes group had the second most prevalence of comorbidities , risky angiographic outcomes , in-hospital morbidity and mortality. Mortality and morbidity was highest in the ST-segment depression group, then no ischemic changes, T-wave inversion then transient ST-segment followed by the elevation. **Conclusion:** Patients with ST-segment depression have a greater burden of comorbidities and coronary atherosclerosis and have a greater risk of in-hospital morbidity

and mortality compared with the other groups. followed by no ischemic changes group ,inverted T group.

Keywords : NSTEMI, coronary intervention , ECG

{**Citation:** Mahmoud Rezk, Amr Elnagar, Mohamed Mahrous, Tarek Abo Alazm, Osama Sanad. Influence of presenting electrocardiographic findings on the angiographic outcome, in-hospital morbidity and mortality in patients with non-ST segment elevation myocardial infarction. American Journal of Research Communication, 2015, 3(10): 15-31} www.usa-journals.com, ISSN: 2325-4076.

Introduction

Non-ST segment elevation myocardial infarction (NON-STEMI) is one of the most frequent manifestation of acute coronary syndrome despite advances in medical and interventional treatment mortality and morbidity still high⁽¹⁾ . Risk stratification remains central to implement appropriate therapeutic measures for patients with NSTEMI. The electrocardiogram provides rapid risk assessment for patients presenting with chest pain that permits their allocation to appropriate management algorithms to improve the outcomes⁽²⁾. Patients diagnosed with NSTEMI constitute a heterogeneous group with several variations of electrocardiographic (ECG) findings at presentation, including ST-segment depression, T-wave inversions, transient ST-segment elevation, or no ischemic changes. From previous studies, ST-segment depression has been considered to be a high-risk ECG finding in patients with NSTEMI with an increased risk of early and long-term cardiovascular events, who often benefit from early invasive management⁽³⁾. However, the clinical characteristics, outcomes, and treatment of patients presenting with transient ST-segment elevation have been less well defined. It has been suggested that intensive medical therapy and early angiography are acceptable treatment options for these patients⁽⁴⁾. Limited data are available on the characteristics and treatment of patients with NSTEMI presenting with no ischemic changes. A comparison between these 4 ECG subgroups in NSTEMI has not been previously performed, especially in contemporary practice. Such a comparison would help

better characterize, and give additional insight to, the appropriate treatment of patients with NSTEMI according to the ECG findings.

Patients and methods

Study design

This is a prospective, observational, non-controlled study included four hundred patients with NSTEMI admitted at National Heart Institute, Cairo, Egypt from August 2014 to March 2015 and the patients were classified into 4 groups according to ECG findings. Group (1) patients with ST depression. Group (2) patients with T wave inversion. Group (3) patients with transient ST elevation. Group (4) patients with normal ECG findings. Key inclusion criteria were: patients with NSTEMI and sinus rhythm. Key exclusion criteria were: patient with previous ECG changes, previous coronary angiography or PCI, associated comorbidities (any comorbidity which has influence on resting ECG), Patients with contraindications to coronary angiography.

Baseline evaluation

All patients had review of their medical history on admission to emergency department including analysis of demographic data (age, sex), presence of risk factors of coronary atherosclerosis, associated comorbidities, general and cardiac examination, 12 leads ECG which was performed immediately on admission and every 6 h during the first 24 h, and once daily until discharge, routine laboratory investigations including cardiac biomarkers (Troponin I & CK-MB). Echocardiographic assessment was performed routinely in all patients.

Coronary angiography

Informed written consent was obtained for all patients. The procedure was done according to the standard technique for coronary angiography. Transfemoral approach was done in all patients by using Seldinger technique.

Treatment

All patients received the standard anti-ischemic treatment during emergency and hospital stay.

Follow up

All patients were followed during hospital stay to assess in hospital mortality and morbidity (arrhythmia, HF, angina..etc) in each group

Statistical analysis

Data are presented as mean \pm SD for continuous data and as number (%) for categorical data. Between groups analysis was done using student t-test for continuous data and Chi-square test (or Fischer exact test) for qualitative data. Level of evidence was detected to be significant at P value.

Results

Study population

The mean age was 57 years in all patients .while it was 61, 58, 55 and 54 in group I,II,III, and IV respectively (p <0.001). Men constituted 75.5 % of the study population while female constitutes 24.5% of the study population (p <0.001). Diabetic patients represents 55.75% of the study population ,80%,53%,26% and 64% in group I,II,III,IV respectively (P <0.001) While hypertensive patients represents 64.25% of the study population being 75% ,68% ,51% and 63% in group I,II,III and IV respectively (p =0.004) Current smoking was present in 62% of the study population representing 64% , 67% , 43% and 74 % in group I,II,III and IV respectively (p<0.001). while Ex-smoker patients represent 29.5% of the study population and 32% , 34% , 17% and 35% in group I,II,III and IV respectively (p=0.02). Dyslipidemia represents 51% of the study population being 57% , 60% , 37% and 50% in group I,II,III and IV respectively (p= 0.006) .{ table 1 }

Table (1): Comparison between the studied groups regarding demographic characteristics

Study group Variable	Group I N= 100		Group II N= 100		Group III N= 100		Group IV N= 100		Total N= 400		P
	No.	%	No.	%	No.	%	No.	%	No.	%	
Age											
<55Y	12	12	43	43	47	47	21	21	123	30.75	<0.001 (HS)
55 to <65Y	59	59	46	46	49	49	61	61	215	53.75	
≥65y	29	29	11	11	4	4	18	18	62	15.5	
Mean ± SD	61.17±6.71		55.61±6.05*		54.22±6.10*		58.71±7.0*†‡		57.43±7.0		<0.001 (HS)
Sex											
females	23	23	29	29	26	26	20	20	98	24.5	0.49
males	77	77	71	71	74	74	80	80	302	75.5	
HTN											
No	25	25	32	32	49	49	37	37	143	23.75	0.004 (S)
Yes	75	75	68	68	51	51	63	63	257	64.25	
DM											
No	20	20	47	47	74	74	36	36	177	44.25	<0.001 (HS)
Yes	80	80	53	53	26	26	64	64	223	55.75	
Current smoker											
yes	64	64	67	67	43	43	74	74	248	62	<0.001 (HS)
No	36	36	33	33	57	57	26	26	152	38	
Ex-smoker											
No	68	68	66	66	83	83	65	65	282	70.5	0.02 (S)
Yes	32	32	34	34	17	17	35	35	118	29.5	
Dyslipidemia											
No	43	43	40	40	63	63	50	50	196	49	0.006 (S)
Yes	57	57	60	60	37	37	50	50	204	51	

Group (I) patients with ST depression; Group (II) patients with T wave inversion; Group (III) patients with transient ST elevation; Group (IV) patients with normal ECG findings.

*Significant differences compared to Group I; †Significant differences compared to Group II; ‡ Significant differences compared to Group III.

Ejection fraction in the studied groups

Being an independent mortality risk factor LVEF was studied in all patients with data analysis revealed significant depression of LVEF among all subgroups ($P < 0.004$) higher decline was in ST depression group (44.71 ± 7.27) followed by inverted T group (45.77 ± 7.75), normal ECG group (46.21 ± 9.56) then transient ST elevation group (48.58 ± 5.51) {figure 1}.

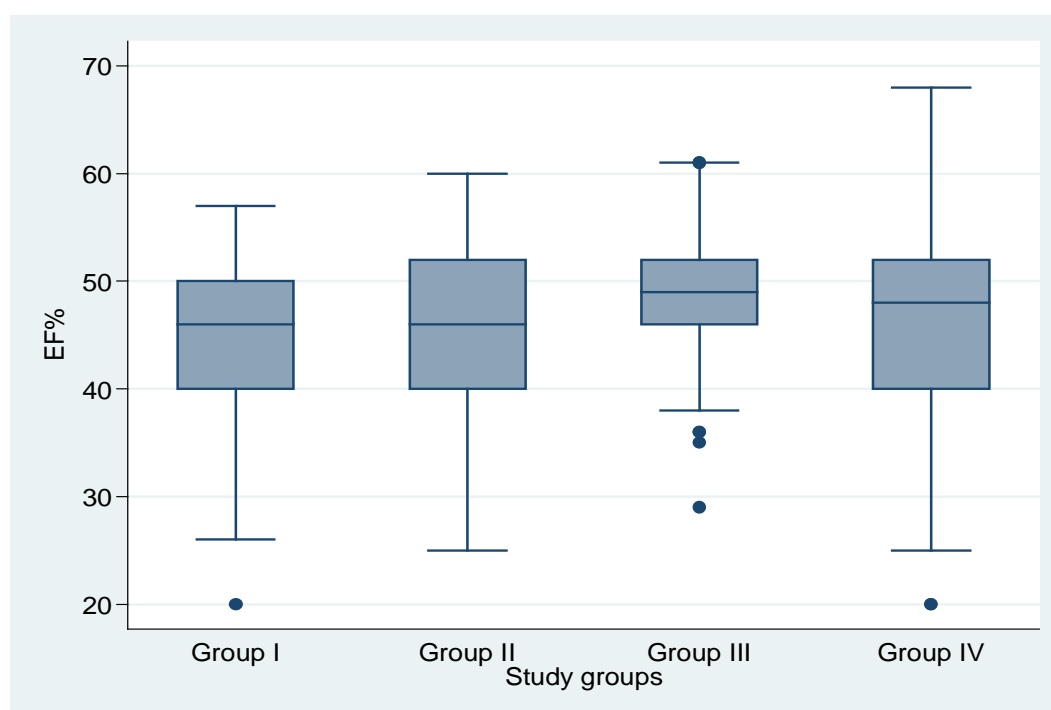


Figure 1: Ejection fraction in the studied groups.

Number of diseased vessel in the studied groups

Statistical analysis of angiographic outcome also revealed that patients who presented with transient ST segment elevation were more likely to have single vessel disease (54%) followed by normal ECG group and inverted T group (32%) and finally the ST depression group (23%). Three vessel CAD are more prevalent in ST depression group (44%) followed by normal ECG group (34%), transient ST elevation group (20%), then T wave

inversion group (19 %).Two vessel disease was more prevalent in inverted T group (49%),followed by ST depression group(33%),normal ECG group (32%) then transient ST elevation (23%).Normal coronary angiography were found in 5 cases (3 cases had transient ST elevation and 2cases have normalECG). {figure 2}.

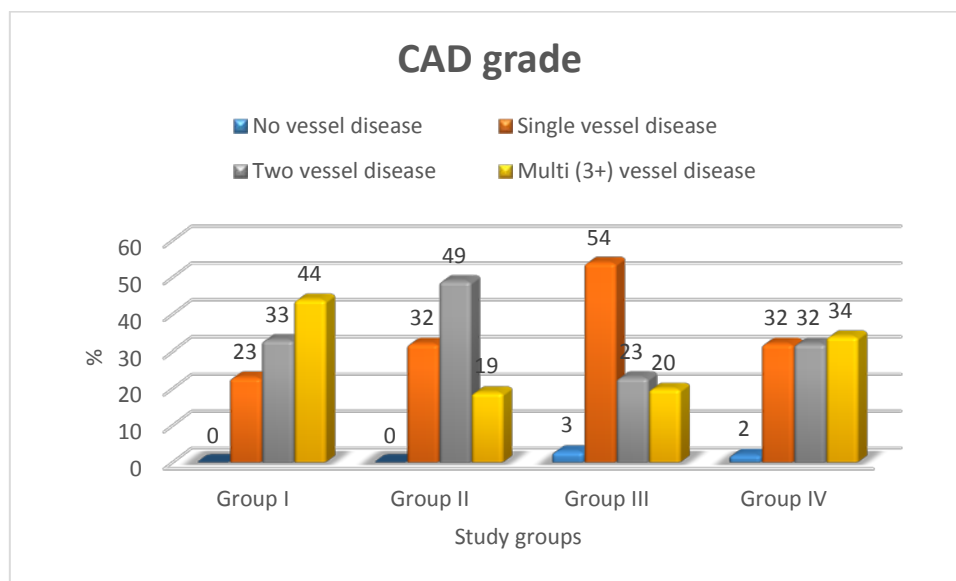


Figure 2: Number of diseased vessel in the studied groups

Angiographic outcome in the studied groups

Angiographic outcome revealed Prevalence of left main disease was higher in ST depression group(9%) followed by normal ECG group(6%), inverted T group (4%) then transient ST elevation group(3%) (p 0.02) .While proximal LAD lesion was higher among ST depression group (57%) followed by inverted T group (48 %), transient ST elevation group (44%) then normal ECG group(40%) with p value 0.095 {table 2 }.

Table (2): Comparison between the studied groups regarding the angiographic outcome

Study group Type of vessel stented	Group I N= 100		Group II N= 100		Group III N= 100		Group IV N= 100		Total N= 400		P
	No	%	No	%	No	%	No	%	No	%	
Left main											
No	91	91	96	96	97	97	94	94	388	94.5	0.02 (S)
Yes	9	9	4	4	3	3	6	6	22	5.5	
Proximal LAD											
No	43	43	52	52	56	56	60	60	211	52.75	0.095
Yes	57	57	48	48	44	44	40	40	189	47.25	

Group (I) patients with ST depression; Group (II) patients with T wave inversion; Group (III) patients with transient ST elevation; Group (IV) patients with normal ECG findings.

Revascularization method in the studied groups

Prevalence of PCI was higher in transient ST elevation group (92 %) followed by inverted T (88 %), normal ECG group (84%) then ST depression group (83%). (P 0.22). But CABG was highest prevalent in ST depression group (16%) followed by normal ECG group (13%), inverted T group (12%) then transient ST elevation group (3%). (P 0.01) {table 3}.

Procedure complication of the studied groups

Complications of PCI were monitored in all study groups, including bleeding, puncture site hematoma, contrast induced nephropathy, dissection, no reflow, acute in-stent thrombosis, TIMI 0-1 flow, perforation, arrhythmia and mortality and its found to be 8 %, 5 %, 3 % and 11 % in group I, II, III and IV respectively (p=0.12) {figure 3}.

Table (3): Comparison between the studies groups regarding management

Study group Variable	Group I N= 100		Group II N= 100		Group III N= 100		Group IV N= 100		Total N= 400		P
	No	%	No	%	No	%	No	%	No	%	
PCI											
No	17	17	12	12	8	8	16	16	53	13.25	0.22
Yes	83	83	88	88	92	92	84	84	347	86.75	
CABG											
No	84	84	88	88	97	97	87	87	360	90	0.01 (S)
Yes	16	16	12	12	3	3	13	13	40	10	

Group (I) patients with ST depression; Group (II) patients with T wave inversion; Group (III) patients with transient ST elevation; Group (IV) patients with normal ECG findings.

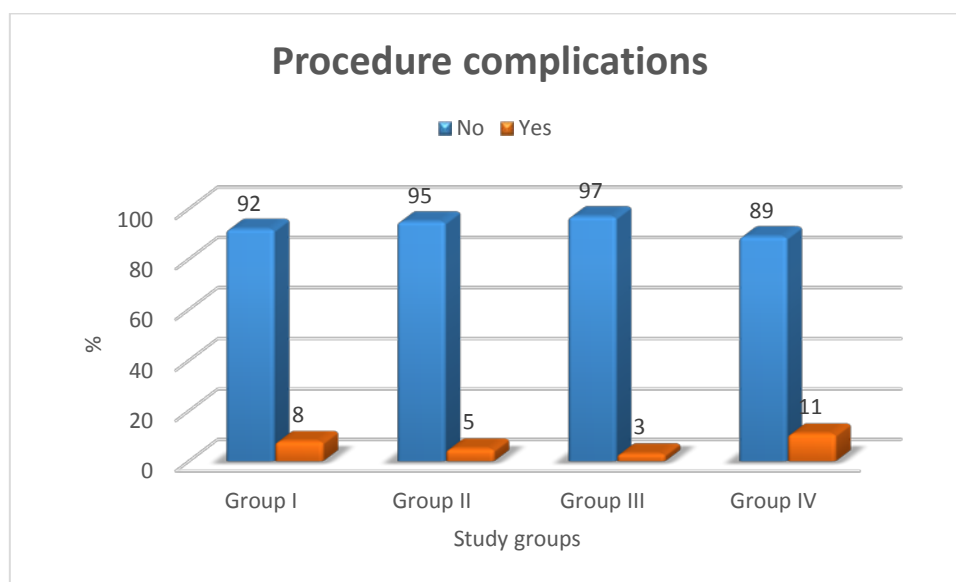


Figure 3: Procedure complication of the studied groups.

In hospital outcome in the studied groups

Follow up of the patient during hospital stay revealed that Prevalence of ischemic attacks was higher in ST depression group (14%) followed by normal ECG group (10 %), inverted T group (9 %) then transient ST elevation group (6%) (p 0.29). Also Prevalence of congestive heart failure was higher in ST depression group (7 %) followed by normal ECG group (5%) and inverted T group (5%) then transient ST elevation group (3%) (p 0.64). Among all patients Mechanical complications occurred only in normal ECG group (2%) and inverted T groups (1%) (p0.62) and arrhythmia was highest among ST depression group (12%) followed by normal ECG group (11%), inverted T (9%) then Transient ST elevation group (6%) (p 0.49) {Table 4}.

Table (4): Comparison between the studied groups regarding in hospital morbidity

Study group Complications	Group I N= 100		Group II N= 100		Group III N= 100		Group IV N= 100		Total N= 400		P
	No	%	No	%	No	%	No	%	No	%	
Ischemic attack											0.29
	No	86 86	91 91	94 94	90 90	329 89.4	14 14	9 9	6 6	10 10	
HF											0.64
	No	93 93	95 95	97 97	95 95	380 95	7 7	5 5	3 3	5 5	
Mechanical complications											0.62
	No	100 100	99 99	100 100	98 98	397 99	0 0	1 1	0 0	2 2	
Arrhythmia											0.49
	No	88 88	91 91	94 94	89 89	362 90.5	12 12	9 9	6 6	11 11	

Group (I) patients with ST depression; Group (II) patients with T wave inversion; Group (III) patients with transient ST elevation; Group (IV) patients with normal ECG findings.

In hospital mortality in the studied groups

statistical analysis of In hospital mortality revealed that highest mortality was among ST depression group (7%) followed by normal ECG (5%) , inverted T group (4%) then transient ST elevation group (1%). (p 0.19) {figure 4}.

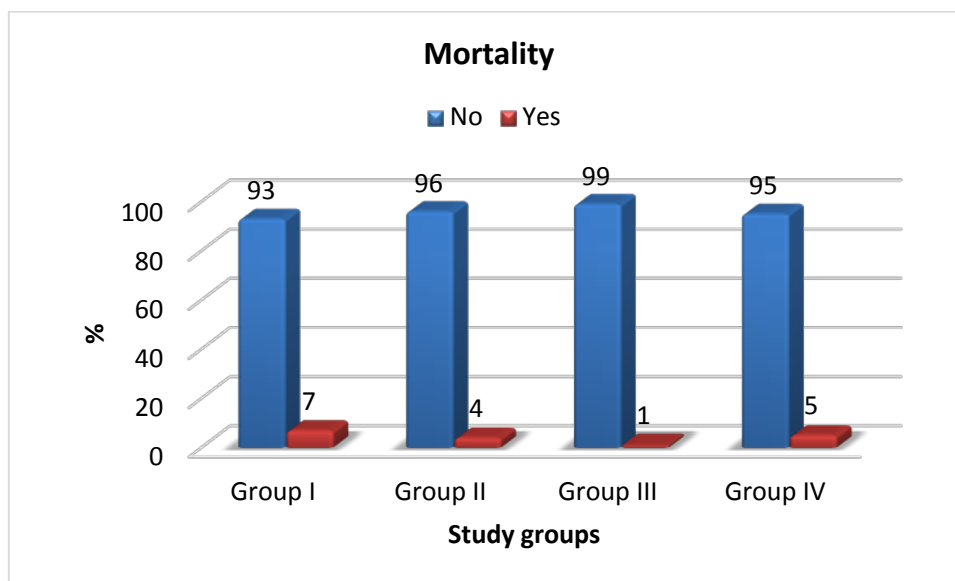


Figure 4: In hospital mortality in the studied groups.

Discussion

NON-STEMI is one of the most frequent manifestation of acute coronary syndrome despite advances in medical and interventional treatment mortality and morbidity still high⁽¹⁾ . Risk stratification remains central to implement appropriate therapeutic measures for patients with non ST-segment elevation myocardial infarction (NSTEMI). The electrocardiogram provides rapid risk assessment for patients presenting with chest pain that permits their allocation to appropriate management algorithms to improve the outcomes ⁽²⁾.Patients diagnosed with NSTEMI constitute a heterogeneous group with several variations of electrocardiographic (ECG) findings at presentation, including ST-segment depression, T-wave inversions, transient ST-segment elevation, or no ischemic changes.The aim of our

study is to demonstrate the influence of the presenting ECG findings on the coronary angiographic outcomes and the associated in-hospital mortality and morbidity.

Thus four hundred patients with Non ST elevation myocardial infarction were included in this study. Patients were divided into four groups. ST depression group, inverted T group, transient ST elevation group and normal ECG group . one hundred patient in each group respectively. Statistical analysis of our study demographic data revealed that patients with ST depression finding on the electrocardiogram were the oldest among all subgroups (mean age 61.17 ± 6.7) and had the highest incidence of comorbidities (hypertension, D.M). Similar results are obtained by savonitto and his co-workers at 1999 in a retrospective study done on 12.142 patients, they found that The patients with ST-segment depression had the worst overall risk profile; they were older and had a worse Killip class, and more of them had diabetes , also Those with T-wave inversion or ST-segment depression had a higher prevalence of hypercholesterolemia and hypertension.they also reported that current smoking was highest among transient ST elevation and inverted T groups⁽³⁾. In our study men constitutes most of the patients in all subgroups (75.5 %) which is in agreement with duan and his co-workers who studied the epidemiology of ACS in 2.135 chinese patients who were recruited during 1994-1996 and followed up until 2012 , they found that men had a higher prevalence of ACS than women across different age categories and different follow-up periods (log rank $\chi^2=20.32$, $P<0.001$)⁽⁵⁾ .Congestive heart failure at presentation was highest in ST depression group (6 %) which is concordant with Ronald and his co-workers in 1993 who studied the long term prognostic significance of ST segment depression in acute myocardial infarction in 1.234 patients , they found that NYHA class > 1 was higher in ST depression group (17 % $p = 0.0392$)⁽⁶⁾ .Our study also revealed that normal ECG group comes next after ST depression group regarding the risk of congestive heart failure at presentation (4 % $p 0.30$). which is concordant with patel and his co-workers who studied the influence of presenting ECG findings in acute coronary syndrome in 2013 they found that signs of congestive heart failure represents 19.4 % out of 105.733 patients with normal ECG ACS⁽⁷⁾. Being the second most important prognostic factor of long term outcomes in ACS patients, LVEF was studied in all patients. our study revealed that highest decline of LVEF was among ST depression group followed by inverted T group, normal ECG group then transient ST elevation group. According to our knowledge there is no comparative studies regarding the relationship between ECG changes and systolic function in acute coronary syndrome patients. Our study revealed a higher frequency of single-vessel

CAD in patients with transient ST-segment elevation (54 %) compared with the other ECG subgroups. Drew et al reported that transient ST-segment elevation occurred almost as frequently as transient ST-segment depression. They also found single vessel disease to be significantly ($p = 0.0007$) more frequent in the transient ST-segment elevation group (46%) compared with the transient ST-segment depression group (22%)⁽⁸⁾ Meisel et al also found a frequency of single-vessel obstructive CAD 60% of inpatients with transient ST-segment elevation⁽⁴⁾ Our study revealed that high risk angiographic findings including Left main CAD, proximal LAD lesion and 3 vessel CAD were highest among ST depression group which is in agreement with Cannon and his co-workers in 1997 who studied how ECG predicts one year outcome of patients with unstable angina and non Q wave MI, they found that 3 vessel disease was more prevalent in ST depression group (33.9 %), the same for Left main CAD (15.3 %) in ST depression group⁽⁹⁾. Also Savonitto and his co-workers in 1999 found that 3 vessel disease CAD are commonest among ST depression group⁽³⁾. Our study also revealed that normal ECG group comes next regarding no. of affected coronary vessels (3 vessel CAD accounts 34 % among all patients of the group) which is discordant with Cannon et al⁽⁹⁾ study which revealed that T wave inversion group comes next after ST depression group regarding high risk angiographic outcomes, this may be due to difference in demographic data, number of patients included in the study and different inclusion criteria, as our current study excluded all patients with history of ischemic heart disease. Incidence of normal or near normal coronary angiography was higher in transient ST elevation group, this is in agreement with Meisel et al. who compared transient with persistent ST elevation in ACS, they found normal or near normal CA to be higher in transient ST elevation group (9.7%)⁽⁴⁾. Revascularization was accomplished either through PCI or CABG. Our study revealed that rate of revascularization through PCI was highest among transient ST elevation group (92 %), this is mostly due to the high prevalence of single vessel disease among this group of patients and this is concordant with Savonitto et al where the rate of angioplasty was highest in ST elevation group (31 %)⁽³⁾. Inverted T ECG group comes next in rate of PCI (84 %) followed by normal ECG group then ST depression group. CABG was higher among ST depression group (16 %) which is concordant with Cannon et al. whose study found rate of CABG in ST depression to be up to (27.2 %)⁽⁹⁾, the same for Savonitto et al who found bypass surgery to be highest among ST depression group (15%)⁽³⁾. In our current study normal ECG group showed the second most prevalence in rate of CABG as a method of revascularization (13%) which is discordant with Cannon et al. who found the rate of CABG to be higher in isolated inverted T group (17.9%) then normal ECG group (14.3%)⁽⁹⁾, this

may be an alarm that delayed intervention in such group of patients results in increased risk of high risk angiographic outcome (3 vessel and left main CAD). In our study we have followed the incidence of revascularization procedures complications in each group, surprisingly the highest incidence was in normal ECG group (11%), which could be explained by delayed intervention in this group, giving another alarm that normal ECG may be a mirror index of a complex cardiovascular problem. although ST depression group patients had the highest prevalence of comorbidities, they came the second in procedure complications (8%). Also in our study we have followed each group to detect the incidence of in hospital complications. In hospital complications were highest among ST depression group (ischemic attacks 14%, H.F 7%, arrhythmia 12%), this clearly augmented by *Antman et al* (TIMI analysis of NSTEMI risk score) who cleared that more than 0.5 mm ST segment deviation is associated with poor outcome⁽¹⁰⁾. *savonitto et al*. also found that 30 day morbidity was higher among ST group⁽³⁾. In this current study mortality was highest among ST depression group (7%) which is in agreement with *Cannon et al.* and *Damman et al.*^(9,11). while normal ECG group (5%) comes next that's discordant with *cannon et al.* who found mortality in inverted T group to be higher than normal ECG group⁽⁹⁾, this may be due to his larger number of patients and different inclusion criteria, also delayed attention to this group of patients may play a role in this high mortality. least mortality was in inverted T group (4%) and transient ST elevation group (1%).

Conclusion

The clinical and angiographic characteristics and treatment and outcomes of patients with NSTEMI differed substantially according to the presenting ECG findings. Patients with ST-segment depression have a greater burden of co-morbidities and coronary atherosclerosis and have a greater risk of in-hospital morbidity and mortality compared with the other groups. followed by no ischemic changes group, inverted T group Normal ECG findings on presentation should raise an alarm of possible complex angiographic and clinical outcome. These findings highlight the importance of integrating the presenting ECG findings into the risk stratification algorithm for patients with NSTEMI

Recommendation

- Based on the results of our study, future research should focus on the role of ECG in risk stratification of patients with acute coronary syndrome .
- Normal ECG findings on presentation should raises an alarm of possible complex angiographic and clinical outcome.
- Underestimation of normal ECG on presentation carry a potential risk of missing high risk patients .
- Early intervention in ST depression and normal ECG NSTEMI patients plays a major role in reduction of morbidity and mortality.
- Early intervention in Transient ST elevation carries the highest successes rate of PCI.

Study limitations

- The sample size was rather small.
- follow-up time was short-term.
- Our study included only one type of acute coronary syndrome , NSTEMI (patient with unstable angina not included)
- There was a difficulty to perform coronary angiography to all patients on emergency basis (financial and resources limitations)
- The population included was only admitted to a single center.

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