Iraqi JMS

Published by Al-Nahrain College of Medicine
P-ISSN 1681-6579
E-ISSN 2224-4719
Email: iraqijms@colmed-alnahrain.edu.iq
http://www.colmed-alnahrain.edu.iq
http://www.iraqijms.net
Iraqi JMS 2019; Vol. 17(3&4)

Higher ST-Segment Elevation in Lead III Than Lead II in Acute Inferior Myocardial Infarction Can Be A Predictor of Short-Term Morbidity and Mortality

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Abstract

Background The incidence of mortality and complications are high in patients with acute inferior wall ST-segment elevation myocardial infarction with right ventricular involvement, which has been reported to be an independent predictor of significant complications and in-hospital mortality.

Objective To investigate the feasibility of using electrocardiographic changes in inferior myocardial infarction represented by ST-segment elevation ratio in lead II and III as a predictor of right ventricular infarction and in-hospital morbidity and mortality.

Methods Ninety-nine patients were studied in this prospective study, their ages ranged from 19-90 years, average 58.12 (±12.7 SD). They were presented to the Coronary Care Unit of Basrah General Hospital with acute inferior ST-segment elevation myocardial infarction. The 12 leads plus right-sided precordial electrocardiograms were done to all patients within 12 hours of the onset of symptoms, and ST-segment elevation was measured. ST-segment elevation in lead III exceeding lead II was defined as a ratio of elevation in lead III: II>1. Patients grouped according to ST-segment elevation III:II ratio into either >1 or ≤1. In-hospital morbidity and mortality were studied in both groups.

Results ST-segment elevation ratio > 1was detected in 68 patients (68.7%) with acute inferior myocardial infarction at time of admission. Right ventricular infarction was diagnosed in 33 (33.3%) patients, with the majority (32 patients) have ST-elevation ratio > 1. Thirty-Six patients had at least one of the in-hospital complications with significantly higher incidence (51.4%) in patients with higher ST elevation ratio. The mortality was statistically higher when ST segment elevation level in the lead III > than that in the lead II.

Conclusion In patients with inferior STEMI, ST-segment elevation in the lead III more than lead II can be a potential marker of the presence of right ventricular infarction in association with inferior myocardial infarction. Short-term prognosis is possibly worse in the presence of a higher ratio between lead III and II ST-segment elevation. However, further studies are needed to validate this conclusion.

Keywords Inferior MI, right ventricular infarction, ST-segment changes

Citation Al-Mansouri LA, Al-Obaidi FR, Al-Humrani AH. Higher ST-Segment elevation in lead III than lead II in acute inferior myocardial infarction can be a predictor of short-term morbidity and mortality. Iraqi JMS. 2019; 17(3&4): 168-174. doi: 10.22578/IJMS.17.3&4.2

List of abbreviations: ECG = Electrocardiogram, LAD = Left anterior descending coronary artery, LCX = Left circumflex coronary artery, LV = Left ventricle, MI = Myocardial infarction, RCA = Right coronary artery, RV = Right ventricle, PCI = Percutaneous coronary intervention, DM = Diabetes mellitus, RVMI = Right ventricle myocardial infarction

Introduction

Acute inferior wall ST-segment elevation myocardial infarction (STEMI) is associated with right ventricular involvement in 30% of cases [1]. Right ventricular (RV) infarction is an independent predictor of complications with an increased risk of death, shock, ventricular tachycardia, ventricular fibrillation, and atrioventricular block. In 80% of acute inferior wall myocardial infarction (MI) cases, the infarct-related artery is right coronary artery (RCA), which is associated with a higher risk of complications, while it is left circumflex coronary artery (LCX) in the rest. Determination of the infarct-related artery in acute MI is essential to predict potential complications.

Furthermore, predicting the probable site of occlusion within RCA is worthwhile because proximal occlusions are more likely to cause greater myocardial damage [2]. Easily recognizable electrocardiogram (ECG) findings that identify high-risk culprit lesion may facilitate the initial management of patients with inferior wall acute MI. Using ECG can provide timely identification of the infarct-related artery and even the location of the culprit lesion within the infarct-related artery [3]. Hospitals without catheterization laboratory need more available tools such as detailed ECG analysis to define high-risk patients with a large jeopardized myocardium [4]. There are many ECG patterns to indicate extensions of the infarction that are associated with different clinical outcomes and necessitate various therapeutic approaches to be applied [5]. The standard 12-lead ECG does not define the RV territory well. Several different additional lead applications may be used to determine RV injury, including a complete reversal of the standard left-sided precordial leads (resulting in V1R through V6R) or the simplified approach using only V4R. In either case, the degree of ST-segment elevation in the right-sided leads may be of a small magnitude because of the relatively smaller RV muscle mass [6]. Therefore, ECG criteria have been suggested to define the infarct-related artery including ST-elevation ratio between leads II and III. Higher elevation of ST segment in lead III in comparison with lead II (ST elevation III > ST elevation II) is a possible indicator of the RCA as the culprit artery while ST-segment elevation in the lead III less than in lead II (ST elevation III < ST elevation II) may indicate the LCX as the probable culprit artery [7,8].

The objective of this study was to investigate the feasibility of using electrocardiographic changes in inferior myocardial infarction represented by ST-segment elevation ratio in lead II and III as a predictor of right ventricular infarction, in-hospital morbidity and mortality.

Methods

Ninety-nine patients were included in this prospective study; their ages ranged from 19-90 years, mean age 58.12 years (±12.7 SD), presented to the Coronary Care Unit of Basra General Hospital with Acute Inferior STEMI from March 2009 to April 2010. The 12 leads plus right-sided precordial ECG was recorded within 12 hours of presentation, and ST-segment elevation was measured. Myocardial infarction was defined according to WHO criteria [9]. Inferior STEMI was determined by ST-segment elevation >1 mm in 2 or more of leads II, III, and aVF on the baseline ECG. Right Ventricular infarction diagnosed with ST elevation >1 mm in the V4R lead. ST-segment elevation in lead III exceeding lead II was defined as a ratio >1. Patients grouped according to ST-segment elevation III: II ratio into either >1 (Group 1) or ≤1 (Group 2). In-hospital morbidity and mortality; including the incidence of death, cardiogenic shock (blood pressure of ≤ 90/60 mmHg with evidence of decreased organ perfusion) [10] and arrhythmias; were studied in both groups. For each of the 99 patients, the clinical characteristics (including the history of hypertension, diabetes mellitus (DM), ischemic heart diseases, and smoking) and demographics were analyzed. Investigations were done to all patients including serum Troponin, and blood sugar. Management of patients with STEMI mainly pharmacological with thrombolytic therapy as invasive therapy (primary percutaneous coronary intervention (PCI)) is not available at our hospital. Other medications were received by the patients include aspirin, clopidogrel, lipid-lowering agents, IV infusion of unfractionated heparin, IV normal saline in patients with hypotension and treatment of hypertension and DM.

Results

ST-segment elevation ratio was >1 in 68 patients (68.7%) with acute inferior STEMI at time of cardiac care unit admission and ≤1 in 31 patients (31.3%). A higher number of patients (n=41, 41.4%) with ST-segment elevation ratio >1 were older (more than 60 years) with more male patients in this group than female (Tables 1 and 2).

Table 1. Distribution of the patients according to age

Age (Years)	Group1 No. (%)	Group2 No. (%)	Total No. (%)	*P* value
<40	3 (50%)	3 (50%)	6 (100%)	0.69
40-49	13 (68%)	6 (32%)	19 (100%)	0.159
50-59	11 (52%)	10 (48%)	21 (100%)	0.86
>60	41 (77%)	12 (23%)	53 (100)	0.001

Table 2. Distribution of the patients according to sex

Sex	Group1 No. (%)	Group2 No. (%)	Total No. (%)	*P* value
Male	51 (68%)	24 (32%)	75 (100%)	0.0001
Female	17 (70%)	7 (30%)	24 (100%)	0.084

The prevalence of diabetes was significantly higher in group 1 than group 2, (30.3%) vs. (10.1%) respectively. The prevalence of hypertension (29.2% vs. 9%), history of ischemic heart disease (20.2% for vs. 9%) and smoking (29.2% vs. 12.1%) were significantly higher in group 1 than group 2, respectively (Table 3).

Table 3. Risk factors of the patients

Findings	Group1 No. (%)	Group2 No. (%)	*P value*
Diabetes Mellitus	30 (30.3%)	10 (10.1%)	0.001
Hypertension	29 (29.2%)	9 (9%)	0.001
Past Hx of IHD	20 (20.2%)	2 (2%)	0.004
Smoking	29 (29.2%)	12 (12.1%)	0.001

Right ventricular involvement rate was 33 (33.3%) overall, with 32 patients (32.3%) in group 1 and only one patient (1%) in group 2; there was a highly significant association between Right ventricle myocardial infarction (RVMI) and ST elevation ratio >1, p=0.0001 (Table 4).

Table 4. Comparison of Right ventricle myocardial infarction risk according to ST-segment elevation ratio

Findings	Group1 No. (%)	Group2 No. (%)	Total No. (%)
Positive	32 (96%)	1 (4%)	33 (100%)
Negative	36 (54.5%)	30 (45.5%)	66 (100%)
Total	68 (68.6%)	31 (31.4%)	99 (100%)

p=0.0001

Thirty-six patients (36.3%) had at least one of the in-hospital complications, and a significant association was identified with group 1 as 35 patients (35.3%) were in group1 vs. one patient (1%) in group 2, p=0.0001 (Table 5).

Table 5. Comparison of in-hospital complications risk according to ST-segment elevation ratio

Findings	Group1 No. (%)	Group2 No. (%)	Total No. (%)
Present	35 (97.2%)	1 (2.8%)	36 (100%)
Absent	33 (52.3%)	30 (47.7%)	63 (100%)
Total	68 (68.6%)	31 (31.4%)	99 (100%)

Discussion

This study aims to determine the utility of ECG criteria suggested by previous studies to predict prognosis in patients with acute inferior MI [6, 8]. The rate of inferior MI is about 40–50% of all infarctions, with short-term mortality rates, ranging from 2-9% [11]. The overall survival of inferior STEMI is better than anterior STEMI, but when inferior STEMI is complicated by RVMI; particularly in those with ventricular arrhythmias [12]; the mortality is increased [13]; other significant predictors of six months mortality included age, female gender, diabetes, angina, and stroke [3]. The standard 12-lead ECG plus right-sided leads is a useful screening tool for RVMI complicating inferior STEMI, which has prognostic implications as an independent predictor of poor outcomes compared to anterior STEMI and inferior STEMI without RVMI [14]. The incidence of RVMI in acute Inferior STEMI in this study was 33.3% which was consistent with other studies [15,16]. The association between the incidence of RVMI and ST-segment elevation ratio more than 1 was statistically significant. ST-segment elevation in the lead III more than lead II might suggest the involvement of the right coronary artery rather than the left circumflex artery [17]. Calculation of this ratio may be a useful screening tool for RVMI with the likelihood of RV MI with inferior MI is low in patients with ST-segment elevation in lead III<II [2].

This study showed a 19.1% in-hospital mortality in group 1 as compared with 0.0% in group 2 patients. ST-segment elevation in lead III>II have associated with a statistically significant (p=0.008) higher in-hospital mortality, which is consistent with previous studies [18,19]. The possible explanation for higher mortality rate is increased incidence of ventricular tachycardia and ventricular fibrillation, as the right ventricle may be more arrhythmogenic than the left ventricle in acute ischemia [20]. The overall incidence rate of in-hospital complications (cardiogenic shock, high degree heart block, VT, VF, AF) is 36.3%. In-hospital complications were significantly higher in group 1 as compared with group 2, indicating the potential value of ST elevation ratio to predict the morbidity of patients with inferior STEMI. Risk stratification had been assessed by other studies, presenting a 47% incidence of major in-hospital complications and found in-hospital morbidity to be increased in associations with RVMI [19,21]. A study involving patients with RVMI, showed a high frequency of VF in inferior STEMI with RVMI [2]. During this study, a transient AF developed in 7 (7.07%) patients, 7.3% patients had third-degree AV block for group 1 and 0.0% for group 2, and 8.8% of second-degree AV Mobitz II Block for group 1 and 0.0% for group 2. Inferior STEMI patients are uniquely susceptible to different types of heart block including Mobitz II AV block and third-degree heart block. There is a 10–20% incidence of high-degree heart block in inferior STEMI patients (21% for inferior MI with RVMI and 9.1% without); women and patients older than 70 years have a slightly increased incidence [22]. Serrano Jr and colleagues showed that 13% incidence of third-degree AV block and 5% for Mobitz II block on admission ECG in patients with inferior STEMI [23] with a higher rate of in-hospital mortality in inferior MI patients with heart block. Increased mortality could be the result of a larger infarct size rather than the consequence of heart block. Mortality rate was similar one year after hospital discharge. The onset of heart block may be variable from a progressive delay of conduction to the sudden development of third-degree heart block, and most patients will develop heart block within 24 hours of admission [22].

Cardiogenic shock was more frequent in group1patient (11.1%) than group 2 (1%). All patients with cardiogenic shock have RVMI, and there is a statistically significant association between cardiogenic shock and RVMI (p=0.0001). Recent studies have focused attention on the problem of cardiogenic shock associated with RVMI and have provided insights on the management and outcomes. A study showed an incidence rate of 6.9% in patients with inferior STEMI with RVMI and 5.5% without [2]. Alice Jacobs and colleagues reported a 5% rate of cardiogenic shock caused by RVMI [24].

Finally, in patients with RVMI complicating inferior STEMI, in-hospital PCI can reduce mortality compared with patients without RVMI even in those who treated with fibrinolytic therapy. So, the prognostic importance of ST elevation ratio in patients with inferior STEMI is of potential value to identify the patients with associated RVMI who are considered as a high-risk group and can benefit from an early invasive strategy [19].

Limitations of the study

The small sample size can affect the conclusions of the study. Furthermore, there is no reference investigation such as coronary angiography to validate the results of the study. The demographics of the patients showed a significantly higher prevalence of risk factors in group 1 patients which can be a contributing factor to the worse outcomes in those patients.

Conclusions

In patients with inferior STEMI, ST-segment elevation ratio in the lead III more than lead II can be a potential marker of the presence of RV infarction in association with inferior STEMI. Short-term prognosis is possibly worse in the presence of a higher ratio. However, further studies are needed to validate this conclusion.

Acknowledgement

The authors appreciate thankfully the role of all patients who participate in this study.

Author contribution

Dr Al-Mansouri and Dr Al-Obaidi: collection, analysis of data, interpretation and discussion of results done by both authors. Dr Al-Humrani: concept, supervision and revising the manuscript.

Conflict of interest

None to declare.

Funding

No funding sources for this paper.

References

1. Khan S, Kundi A, Sharieff S. Prevalence of right ventricular myocardial infarction in patients with acute inferior wall myocardial infarction. Int J Clin Pract. 2004; 58(4): 354-7. doi: 10.1111/j.1368-5031.2004.00030.x.
2. Mehta SR, Eikelboom JW, Natarajan MK, et al. Impact of right ventricular involvement on mortality and morbidity in patients with inferior myocardial infarction. J Am Coll Cardiol. 2001; 37(1): 37-43. doi: 10.1016/s0735-1097(00)01089-5.
3. Nair R, Glancy DL. ECG discrimination between right and left circumflex coronary arterial occlusion in patients with acute inferior myocardial infarction: value of old criteria and use of lead aVR. Chest. 2002;122(1):134-9. doi: 10.1378/chest.122.1.134.
4. Ribichini F, Wijns W. Acute myocardial infarction: reperfusion treatment. Heart. 2002; 88(3): 298-305. doi: 10.1136/heart.88.3.298.
5. Correale E, Maggioni AP, Romano S, et al. Comparison of frequency, diagnostic and prognostic significance of pericardial involvement in acute myocardial infarction treated with and without thrombolytics. Am J Cardiol. 1993; 71(16): 1377-81. doi: 10.1016/0002-9149(93)90596-5.
6. Moye S, Carney MF, Holstege C, et al. The electrocardiogram in right ventricular myocardial infarction. Am J Emerg Med. 2005; 23(6): 793-9. doi: 10.1016/j.ajem.2005.04.001.
7. Kontos MC, Desai PV, Jesse RL, et al. Usefulness of the admission electrocardiogram for identifying the infarct-related artery in inferior wall acute myocardial infarction. Am J Cardiol. 1997; 79(2): 182-4. doi: 10.1016/s0002-9149(96)00709-6.
8. Herz I, Assali AR, Adler Y, et al. New electrocardiographic criteria for predicting either the right or left circumflex artery as the culprit coronary artery in inferior wall acute myocardial infarction. Am J Cardiol. 1997; 80(10): 1343-5. doi: 10.1016/s0002-9149(97)00678-4.
9. Luepker RV, Apple FS, Christenson RH, et al. Case definitions for acute coronary heart disease in epidemiology and clinical research studies: a statement from the AHA Council on Epidemiology and Prevention; AHA Statistics Committee; World Heart Federation Council on Epidemiology and Prevention; the European Society of Cardiology Working Group on Epidemiology and Prevention; Centers for Disease Control and Prevention; and the National Heart, Lung, and Blood Institute. Circulation. 2003; 108(20): 2543-9. DOI: 10.1161/01.CIR.0000100560.46946.EA.
10. Palmeri ST, Lowe AM, Sleeper LA, et al. Racial and ethnic differences in the treatment and outcome of cardiogenic shock following acute myocardial infarction. Am J Cardiol. 2005; 96(8): 1042-9. doi: 10.1016/j.amjcard.2005.06.033.
11. Pfisterer M, Emmenegger H, Solèr M, et al. Prognostic significance of right ventricular ejection fraction for persistent complex ventricular arrhythmias and/or sudden cardiac death after first myocardial infarction: relation to infarct location, size and left ventricular function. Eur Heart J. 1986; 7(4): 289-98. doi: 10.1093/oxfordjournals.eurheartj.a062066.
12. Rotondo N, Pollack ML, Chan TC, et al. Electrocardiographic manifestations: acute inferior wall myocardial infarction. J J Emerg Med. 2004; 26(4): 433-40. doi: 10.1016/j.jemermed.2004.01.012.
13. Kinch JW, Ryan TJ. Right ventricular infarction. N Engl J Med. 1994; 330(17): 1211-7. doi: 10.1056/NEJM199404283301707.
14. Akbar AM, Nadeem MA, Waseem T, et al. Right ventricular involvement in inferior wall myocardial infarction: Incidence, clinical spectrum and in hospital outcome. Ann King Edward Med Uni. 1999; 5(2): 152-5.
15. Isner JM, Roberts WC. Right ventricular infarction complicating left ventricular infarction secondary to coronary heart disease: frequency, location, associated findings and significance from analysis of 236 necropsy patients with acute or healed myocardial infarction. Am J Cardiol. 1978; 42(6): 885-94. doi: 10.1016/0002-9149(78)90672-0.
16. Chia BL, Yip JW, Tan HC, et al. Usefulness of ST elevation II/III ratio and ST deviation in lead I for identifying the culprit artery in inferior wall acute myocardial infarction. Am J Cardiol. 2000; 86(3): 341-3. doi: 10.1016/s0002-9149(00)00929-2.
17. Saw J, Davies C, Fung A, et al. Value of ST elevation in lead III greater than lead II in inferior wall acute myocardial infarction for predicting in-hospital mortality and diagnosing right ventricular infarction. Am J Cardiol. 2001; 87(4): 448-50. doi: 10.1016/s0002-9149(00)01401-6.
18. Owens C, McClelland A, Walsh S, et al. Right ventricular infarction complicating inferior myocardial infarction correlates with higher TIMI risk scores and increased in-hospital morbidity and mortality. J Electrocardiol. 2004; 37: 150. doi: 10.1016/j.jelectrocard.2004.08.044.
19. Behar S, Zissman E, Zion M, et al. Complete atrioventricular block complicating inferior acute wall myocardial infarction: short-and long-term prognosis. Am Heart J. 1993; 125(6): 1622-7. doi: 10.1016/0002-8703(93)90750-4.
20. Huikuri HV, Castellanos A, Myerburg RJ. Sudden death due to cardiac arrhythmias. N Engl J Med. 2001; 345(20): 1473-82. DOI: 10.1056/NEJMra000650.
21. Zehender M, Kasper W, Kauder E, et al. Right ventricular infarction as an independent predictor of prognosis after acute inferior myocardial infarction. N Engl J Med. 1993; 328(14): 981-8. doi: 10.1056/NEJM199304083281401.
22. Serrano Jr CV, Bortolotto LA, César LAM, et al. Sinus bradycardia as a predictor of right coronary artery occlusion in patients with inferior myocardial infarction. Int J Cardiol. 1999; 68(1): 75-82. doi: 10.1016/s0167-5273(98)00344-1.
23. Nicod P, Gilpin E, Dittrich H, et al. Long-term outcome in patients with inferior myocardial infarction and complete atrioventricular block. J Am Coll Cardiol.

1988; 12(3): 589-94. doi: 10.1016/s0735-1097(88)80042-1.
24. Jacobs AK, Leopold JA, Bates E, et al. Cardiogenic shock caused by right ventricular infarction: a report from the SHOCK registry. J Am Coll Cardiol. 2003; 41(8): 1273-9. doi: 10.1016/s0735-1097(03)00120-7.

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Received Jan. 17th 2019
Accepted Aug. 19th 2019