

REVIEW ARTICLES

Prediction of Location of Infarct-related Artery in acute Myocardial Infarction from Surface Electrocardiogram, its Clinical Importance and Therapeutic Strategy: A Review

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Introduction:

Acute myocardial infarction is a common disease with serious consequences in mortality, morbidity, and cost to the society.¹ Acute myocardial infarction (AMI) has always been a potential health problem due to the life-threatening complications. Coronary atherosclerosis plays a pivotal part as the underlying substrate in many patients.² MI results from prolonged myocardial ischemia precipitated in most cases by an occlusive coronary thrombus at the site of a pre-existing atherosclerotic plaque.¹ Although coronary angiogram (CAG) is the gold standard to localize the site of coronary obstruction, ECG is an important tool in determining therapeutic strategy in acute coronary syndrome (ACS) in the setting of AMI.³

Discussion:

The diagnosis of infarct related artery (IRA) is very important with regard to the prediction of potential complications and subsequent therapeutic strategy in acute inferior myocardial infarction (AIMI). The IRA is right coronary artery (RCA) in 80% of cases, while it is left circumflex (LCX) in the rest.² AIMI is sometimes complicated by hypotension or bradycardia, generally occurs in case of proximal RCA occlusion. So it is clinically important to determine proximal RCA occlusion to predict their potential complications and outline the therapeutic strategy in AIMI.³

Erdem Alim et al have studied sixty patients admitted to their center with diagnosis of AIMI.

Inclusion Criteria: acute inferior myocardial infarction is defined as presence of persistent ischemic chest pain (>30 min), ST-segment elevation at least 1 mm in at least two of the inferior leads (L2, L3, aVF) and presence of at least two fold increase of cardiac biomarker (CK-MB) level compared to normal baseline value. Exclusion criteria: ST-segment

elevation of <1 mm in inferior leads, ST-segment elevation other than inferior leads, left ventricular hypertrophy (LVH), left bundle branch block (LBBB), presence of conditions causing ECG changes (electrolytes disturbances, myocarditis, pericarditis etc).³

Erdem Alim et al has shown the patients with the culprit lesion in the proximal portion were found to have a mean ST segment elevation >12 mm but in the mid RCA and distal RCA portion were found 6 mm and 5 mm, respectively.³

A ST segment elevation value of >9 mm was found to have sensitivity and specificity of 91.3% and 94.6%, respectively in the prediction of infarct related proximal RCA lesions.³

The presence of more severe ST segment elevation in the L3 compared to that in L2 was found to have a sensitivity of 99%, specificity 100% and positive predictive value of 99% in the RCA occlusion in AIMI.⁴

Anterior MI carries worst prognosis of all infarct locations, mostly due to large infarct size. A study comparing outcomes from anterior and inferior infarctions (STEMI+NSTSEMI) founded that on average, patients with anterior MI had higher incidences of in-hospital mortality (11.9 vs 2.8%), total mortality (27 vs 11%), heart failure (41 vs 15%) and significant ventricular ectopic activity (70 vs 59%) and a lower ejection fraction on admission (38 vs 55%) compared to patients with inferior MI.^{5,6}

A number of studies have focused on the relationship between ECG changes and infarct related artery (IRA).

Birnbaum et al propounded ST segment depression in aVL lead- one of the sensitive and earliest parameter of AIMI.⁷

Patients with an abnormal R wave in V1 (0.04 second in duration and R/S ratio >1 in the absence of pre-excitation or right ventricular hypertrophy (RVH) with inferior or lateral Q waves have an increased incidence of isolated occlusion of a dominant LCX without collateral circulation.⁸

Berry et al demonstrated that ST segment depression in both aVL and L1 leads was a marker of RCA occlusion in AIMI.⁹

Right-sided ST-segment elevation is indicative of acute right ventricular injury and usually indicates occlusion of the proximal RCA. Acute RVI projects an injury current in leads V1-V3, thereby simulating anterior infarction.¹⁰ Leads aVR may provide important clues to artery occlusion in MI.¹¹

Zehender et al found an incidence of 27% of RVI associated with inferior MI based on electrographic criteria.²² In AIMI the more severe ST-segment elevation in L2 compared to that in L3 was found to have positive predictive value of 98% in the LCX occlusion.¹¹ Inferior MI with ST depression in V1-V3 more associated with LCX occlusion (71%) than RCA occlusion.¹²

Ratio of ST-segment depression in V3 to ST-segment elevation in L3 < 0.5 predicts proximal RCA occlusion, 0.5-1.2 predicts distal RCA occlusion and > 1.2 predicts LCX occlusion.¹²

Inferior MI with ST-segment elevation in lateral leads (I, aVL, V5 & V6) sensitive and specific marker for LCX occlusion.⁸

Acute anteroseptal MI (with STE maximal in lead V1-V4), the following signs suggests proximal LAD occlusion: presence of ST-segment depression >1mm in inferior leads, ST-segment elevation in lateral leads (aVL), ST-segment elevation in lead aVR and right bundle branch block (RBBB).¹³ Left main or severe multi-vessel disease should be considered when leads aVR and V1 show ST-segment elevation with diffuse prominent ST depression in other leads.^{11, 14}

STE in aVR of any magnitude is 43% sensitive and 95% specific for proximal LAD occlusion.¹³

RBBB in anterior MI is an independent marker of poor prognosis; this is due to the extensive myocardial damage involved rather the conduction disorder itself.¹³

Inferior lead ST-segment elevation accompany acute anterior MI suggesting either primary occlusion of a LAD that extends onto the inferior wall of LV (*the type III or wrap-around LAD*) or multi vessel disease (MVD) with jeopardized collaterals.¹⁵

Deep symmetrical precordial T wave inversions > 2mm or biphasic T waves in V2-V3 indicating proximal LAD occlusion: a warning sign of imminent anterior infarction (*Wellens syndrome*).²³ A new ECG sign of proximal LAD occlusions: Upsloping ST depression with symmetrically peaked T waves in the precordial leads; a “STEMI equivalent” indicating acute LAD occlusion (*de Winter’s T wave*).¹⁶

An isolated true posterior MI is unusual, less common (3-11% of infarcts). Posterior MI accompanies 15-20% of STEMIs usually occurring in the context of an inferior or lateral wall infarction. In such situation, the ECG changes of posterior wall infarction (Tall, broad R waves (>30ms) with ST-depression in V1-V2, upright T wave, dominant R wave (R/S ratio >1 in V2) are added.¹⁷

Clinical Importance:

Therefore, it is clinically important to determine the proximity of culprit lesion along RCA to predict the patients potentially at risk for AIMI related complications including brady-arrhythmia and severe hypotension.³ Right ventricular infarction is associated with increased risk of death, ventricular tachycardia or fibrillation and atrioventricular blocks.¹⁸ The frequency of VF and iatrogenic coronary dissection is higher when RCA is injected in the presence of a damped pressure tracing indicating ostial stenosis. Posterior extension of inferior or lateral infarct implies a much larger area of myocardial damage, with increased risk of LV dysfunction and death.¹⁷

It is pertinent to define the site of occlusion of LAD in the setting of AMI because proximal LAD occlusion needs more aggressive approach to revascularization to prevent extensive myocardial damage, development of sub-AV nodal conduction disturbances and occurrence of life threatening arrhythmias.¹⁰ Massive ST elevation with “*tombstone*” morphology is present throughout the precordial (V1-V6) and high lateral leads (I, aVL); this pattern is seen in proximal LAD occlusion and indicates a large territory infarction with poor LV ejection fraction and high likelihood of cardiogenic shock and death.^{5,13} In LMCA disease, most patients are symptomatic and high risk of CV events, since occlusion of this vessel compromises flow to at least 75% of LV, unless it is protected by collateral flow or a patent bypass graft to either the LAD or LCX.^{6,11}

Therapeutic strategy:

In patients presenting with inferior STEMI, who received fibrinolytic therapy, a routine invasive strategy with early CAG and intended revascularization, achieve a clinical outcome similar to an ischemia-guided strategy in which

catheterization was based on the presence of myocardial ischemia and viability as demonstrated by stress-myocardial perfusion imaging (MPI).¹⁹ Pre hospital fibrinolytics with timely (6-24h) CAG with a view to revascularization (Pharmacoinvasive strategy) results in effective reperfusion in patients with early STEMI who could not undergo primary PCI (*pPCI*) within 1 hour after first medical contact.²⁰ In the strategic reperfusion early after MI (STREAM) trial, a pharmacoinvasive (PI) strategy was compared to the *pPCI* in STEMI patient presenting within 3 hours after symptoms onset but unable to undergo *pPCI* within 1 hour, at one year mortality rates in the PI and *pPCI* arms were similar.

Isolated posterior infarction is an indication for emergent coronary reperfusion.¹⁷

The appropriateness of coronary artery bypass (CABG) surgery versus percutaneous coronary intervention (PCI) is predicted on clinical, anatomic and functional grounds. In the coronary artery surgery study (CASS), isolated left main coronary artery (LMCA) disease, left main equivalent (proximal LAD and LCX) CAD or three vessels CAD with LV dysfunction has demonstrated long term survival benefit from CABG surgery. Patients with an isolated high grade lesion of the proximal LAD have a significant better 4-year clinical outcome after off-pump CABG than after PCI.²¹ Major adverse cardiac events (MACES) occurred 27.5% after stenting and 9.8% after surgery, freedom from angina was 67% after stenting and 85% after surgery, need for anti-anginal medication was significantly lower after surgery compared to stenting.²² By contrast, in patient with relatively simple LMCA diseases, such as ostial / shaft LMCA disease, isolated LMCA disease with or without one or two vessel involvement and LMCA disease with low SYNTAX (Synergy between PCI with Taxus and Cardiac Surgery trail) score, PCI is an alternative and in some cases a preferred strategy to reduce surgical risks (e.g. stroke).²¹ PCI is indicated in patients with suitable anatomy with refractory or lifestyle-limiting angina who have failed a course of optimum medical therapy (OMT).

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