

The Diagnostic Accuracy of Electrocardiogram in Differentiating Takotsubo Cardiomyopathy in Patients Presenting as Anterior Wall ST-Segment Elevation Myocardial Infarction and Taking Coronary Angiography as Gold Standard

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ABSTRACT

Myocardial infarction: Myocardial infarction is the irreparable damage to heart muscles resulting in necrosis & is the leading cause of death; resulting in 500,000-700,000 important deaths related to the coronary artery occur each year. Cardiovascular disease is the most common reason resulting in premature mortality as well as morbidity among various ethnic group of white, black and Hispanic populations.

Takotsubo Cardiomyopathy: TCM is a condition that affects the heart reversible syndrome, characteristic of decrease(hypokinesia)/ near absent movement (akinesia) of distal half of interventricular septum & cardiac apex showed as apical ballooning on echocardiogram with absence of an obstructive defect in epicardial coronary arteries following an emotional disturbance.

Objective: To determine the diagnostic accuracy of electrocardiographic findings (elevation < 1mm Takotsubo cardiomyopathy can be identified in lead V1 in patients who have anterior wall ST-segment elevation myocardial infarction by taking coronary angiography as gold standard.

Design: Cross-sectional survey

Subjects & Methods: Using 250 incidences in the sample, and a 95% confidence level, a 13% error margin, and the anticipated percentage of Takotsubo cardiomyopathy i.e, 18% by using 74.2% sensitivity and 80.6% specificity of electrocardiographic findings i.e, ST-elevation of > 1mm in V₁ in the detection of Takotsubo cardiomyopathy when myocardial infarction with ST-elevation in the anterior wall is the presenting symptom and coronary angiography as gold standard².

Results: The patients were 49 + 13 years old on average. Sensitivity & specificity of ECG criteria were 40.78% & 78.65%. The positive & negative predictive values were 43.28% & 76.5% respectively.

Practical Implication: Our study showed negative association of ST-elevation of >1mm in ECG lead V₁ to differentiate TC from anterior wall myocardial infarction. Further studies should be done to probe into the diagnostic accuracy of ECG in differentiating TC from acute anterior wall myocardial infarction.

Conclusion: Electrocardiography is not diagnostic for distinguishing acute anterior wall pain from Takotsubo cardiomyopathy myocardial infarction so additional investigations need to be performed to diagnose the Takotsubo Cardiomyopathy.

Keywords: Myocardial infarction, Takotsubo cardiomyopathy, Electrocardiogram, diagnostic accuracy Coronary angiography.

INTRODUCTION

Stress-induced cardiomyopathy, also known as apical ballooning syndrome, shattered heart syndrome, or Takotsubo cardiomyopathy (TC), is a rare condition that affects postmenopausal women. It accounts for 1.7 to 2.2% of people who present with suspected acute coronary syndrome (ACS)¹. The study found that ST-segment elevation >1 mm in >1 of leads V3 to V5 without ST-segment elevation >1 mm in lead V1 may detect Takotsubo cardiomyopathy with a sensitivity of 74.2% and specificity of 80.6%. In contrast to acute anterior wall ST-segment myocardial infarction, which had a prevalence of 19.6%, Takotsubo cardiomyopathy had a prevalence of ST-segment elevation >1mm in >2 contiguous precordial leads without ST-segment elevation >1mm in lead V1. The level of ST-segment elevation assessed at J point was able to distinguish between 62 patients with Takotsubo cardiomyopathy and 280 persons with acute anterior ST-segment elevation MI.²

Myocardial infarction is the ischemic necrosis of cardiac muscles due to severe coronary artery stenosis or obstruction. The stenosis/ obstruction is the result of plaque rupture with superimposed thrombosis of the epicardial vessel previously may or may not be affected by atherosclerosis, resulting in an acute decline in blood flow to a portion of the myocardium.⁴ This results in myocardium deprived of oxygen and metabolic fuels resulting in demand – supply mismatch. Date indicates culprit lesions are stenosis of more than 70% and are located in the initial part of the coronary artery.^{3,4} Coronary atherosclerosis is usually significant where the epicardial vessel gives its branches.⁵ Electrocardiography shows ST-segment elevation of >2 mm in

anterior chest leads. Myocardial infarction is supported by serial rise & fall in cardiac enzymes.³

While coronary angiography normally reveals no obstructive lesions in patients with TC, only a small percentage of them exhibit coronary spasm with acetylcholine provocation⁵. The results of intravascular ultrasonography (IVUS) investigations are conflicting, and it has not been determined if plaque rupture and thrombosis play a role in spontaneous thrombolysis. Although one IVUS investigation identified 5 of 5 individuals with stress-induced cardiomyopathy as having a ruptured mid-left anterior descending (LAD) coronary artery plaque⁷, other IVUS series failed to identify any culprit lesions in the LAD.⁶ Its correlation with physical or psychological stress suggests that this condition may be brought on by indirect catecholamine-associated myocardial toxicity or diffuse catecholamine-induced microvascular spasm or malfunction, leading in myocardial stunning^{14,7-8}

Since there are no local data available, the goal of my study is to establish the positive predictive value of ECG in discriminating Takotsubo cardiomyopathy (TC) in patients presenting with acute anterior wall ST-segment elevation myocardial infarction (STEMI). Since their presentations are highly similar, early diagnostic distinction is crucial for identifying the best course of treatment. Therefore, early decision can be made on the basis of electrocardiogram of anterior wall STEMI and intervention in the coronary arteries primary or rescue Percutaneous coronary intervention(PCI), may be offered to the patient which is superior to the commonly used thrombolytic therapy.

MATERIALS AND METHODS

Study design: Cross-sectional survey

Settings: Emergency and in-patient departments of Punjab Institute of Cardiology, Lahore.

Duration of study: Six months after approval of the synopsis

Sample size: Sample size of 250 cases is calculated with 95% confidence interval, 13% margin of error and taking expected percentage of Takotsubo cardiomyopathy i.e., 18% by using 74.2% sensitivity and 80.6% specificity of electrocardiographic findings i.e., ST-elevation of > 1mm in V₁ in the detection of Takotsubo cardiomyopathy in patients presenting as anterior wall ST-elevation myocardial infarction and coronary angiography as gold standard.

Sample technique: Non-probability purposive sampling

SAMPLE SELECTION:

Inclusion criteria:

1. Patients fulfilling ECG criteria for anterior wall myocardial infarction (as per operational definition)
2. Both genders
3. Age 20 years & above

Exclusion criteria:

1. Previous myocardial infarction (as evident from history or previous medical record of patient)
2. Subjects with cardiac conduction abnormalities on ECG
3. Any other cardiac, pulmonary or systemic metabolic problem affecting the electrocardiographic findings (This information will be based on past medical record of subjects).⁹⁻¹⁰

Data Collection Procedure: 250 cases of acute anterior wall STEMI meeting the inclusion criteria were chosen from the indoor and emergency departments of Punjab Institute of Cardiology, Lahore, after receiving approval from the hospital ethical committee. Each participant or attendant was informed of the study's goal, and their informed consent will be sought. A thorough history and examination were conducted. Patients fulfilling criteria of Takotsubo cardiomyopathy on ECG were marked and later confirmed on echocardiography and coronary angiography. All the patient were thrombolysed as per routine so that there treatment was not affected & were later on evaluated on coronary angiogram. Bias was controlled by recording standard 12 lead ECG keeping speed and voltage constant at 25 mm/sec and 1mV=10mm respectively. ST segment elevation was measured from J point. All this information was collected through a specially designed proformas.

Data Analysis: The collected data was entered into SPSS version 16 and analyzed. The qualitative variables like ECG findings (presence or absence of ST- elevation of of >1mm in V₁) and coronary angiographic findings (presence or absence of critical obstruction > 50% of epicardial coronary artery) were used to generate 2 X 2 contingency table to calculate the sensitivity, specificity, positive predictive value, negative predictive value & accuracy of ECG findings (ST-elevation of > 1mm in V₁) in the detection of Takotsubo cardiomyopathy by taking angiographic findings as gold standard.

RESULTS

Mean age of the patients was 49 + 13 years. 250 patients were included after fulfilling the basic criteria of ECG. Out of these 186 patients were males & 64 patients were females. Male to female ratio was 2.9:1 (Table 1).

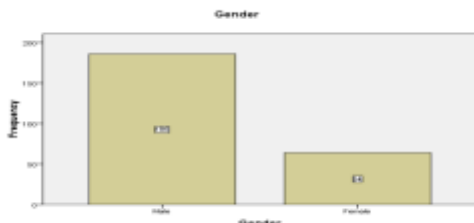


Figure 1:

Most of the patients were in the age group of 41-60 years. (Table 2)

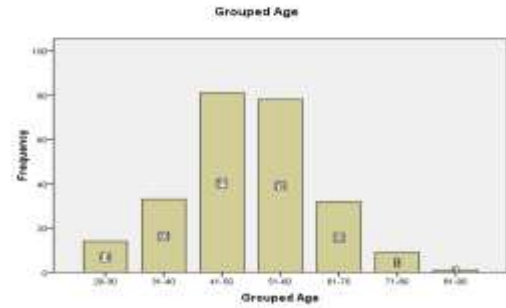


Figure 2:

Following data was obtained when the ECG & angiography findings were arranged in a 2x 2 table.

Table 3: ECG * Angiography Crosstabulation

		Angiography		Total	
		yes	no		
ECG	yes	Count	29	38	67
		% within Angiography	40.3%	21.3%	26.8%
	no	Count	43	140	183
		% within Angiography	59.7%	78.7%	73.2%
Total		Count	72	178	250
		% within Angiography	100.0%	100.0%	100.0%

The data was analysed using SPSS version 16. The following results were obtained

Sensitivity & specificity of ECG criteria were 40.78% & 78.65%. The positive & negative predictive values were 43.28% & 76.5% respectively.

The strength of the study is that it includes a large number of patients. Though the majority of patients in this study belong to male gender. There may be several reasons for it:

- i. Incidence of anterior wall myocardial infarction.
- ii. Male patients frequently get access to hospitals to seek for medical attention.
- iii. Female patients were hesitant in giving consent for coronary angiography.
- iv. As the symptoms of ACS may be atypical in female patients, the presentation is usually delayed to varant inclusion in the study

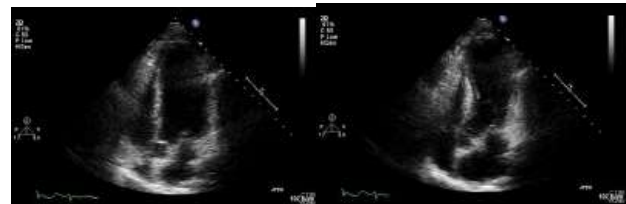


Figure 3: Echocardiogram showing Apical 4 chamber view with decreased movement of mid and apical segments of anterolateral and infero-septal walls which cannot be explained on the basis of single coronary vessel territory

Echocardiography: Transthoracic echocardiography provides a non-invasive method of analyzing regional wall-motion defects characteristics of broken heart syndrome (TCM), which is decreased or absent movements of middle as well as distal regions of the left ventricle. Perhaps most importantly, these wall motion abnormalities do not follow the territories supplied by one coronary vessel.¹¹

After resolution of symptoms the subsequent echocardiographic study demonstrated a significant improvement in left ventricular systolic function and ejection fraction to 59-76% on average, by 3rd week of the event.

Cardiac Angiography: Takotsubo cardiomyopathy (TCM) is diagnosed on coronary angiography which demonstrates absence of significant coronary obstruction. A study of 240 patients diagnosed with TCM, showed vast majority (211) of patients have normal coronary vasculature and some of them have non obstructive lesions. Non obstructive / normal coronaries were also seen in 1-12% of patients initially diagnosed as STEMI. These findings can partly be explained on the basis of vasospasm of coronary arteries by drugs or auto thrombolysis of the epicardial vessels.

Left ventricular angiography shows the classical wall motion abnormality of the mid and distal portion of the left ventricle hall mark of the TC and also provide a good assessment of the left ventricular ejection fraction.

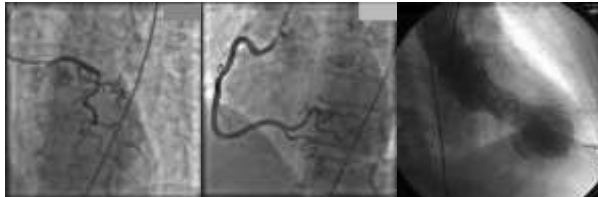


Figure 4: Coronary angiography showing non obstructive coronaries, left ventricular angiogram showing the typical apical ballooning of left ventricle seen in Takotsubo cardiomyopathy

Electrocardiography: ECG is usually the first investigation done in patients who are suspected of acute coronary syndrome (ACS). ST-segment deviation (67-75%) and T-wave abnormalities (61%) are usually seen on first encounter. Majority of patients (95%) with TC shows changes in leads V₂-V₃. When these findings are evaluated against the changes seen in left anterior descending artery (LAD) occlusion (AWSTEMI), the degree of ST-segment elevations in takotsubo cardiomyopathy (TCM) patients was much less. (See the images below.)



Figure 5: ECG showing poor R-wave progression in anterior leads along with T-Wave inversions in leads II, III, AVF, V2-V6, suggestive of myocardial ischemia.

In with TCM, first ECG may be normal in 15% of patients. However, later on generalized T-wave inversions may occur in the upcoming days and weeks following presentation as the ST-segments settles. There is no established criteria to diagnose TCM only on ECG findings and differentiate it from STEMI.^{16,17} A study demonstrated an ECG criteria after evaluating patient in a retrospective way in patients who presented within 6 hours of symptom onset. Absent abnormal Q-waves along with lack of reciprocal changes, without ST-segment elevation in lead V₁, and ST-segment elevation in aVR showed more than 91% sensitivity and 96% specificity for the diagnosis of TCM.

Other Imaging Techniques: Chest radiographs may show pulmonary edema¹²⁻¹³, but usually normal in majority of patients. Cardiac magnetic resonance imaging (CMR) may be reasonable for accurate evaluation of regional wall motion abnormalities seen

in TCM, estimating ventricular function, and detecting reversible injury to the myocardium. This is evident on CMR as edema/inflammation and the absence of necrosis/fibrosis.

DISCUSSION

Myocardial infarction is the irreparable damage to the cardiac myocytes due to prolonged ischemia resulting from occlusion of coronary arteries resulting in decreased supply of oxygen as well as nutrients to heart muscles. This occlusion is usually the result of superimposed thrombosis on plaque rupture of previously atherosclerotic vessel, resulting in an acute decline in blood supply to a portion of the myocardium.^{8,14}

Classification of Myocardial Infarction: Takotsubo cardiomyopathy (TCM) is a potentially life threatening condition that involves mid and distal half of the left ventricle and has close resemblance with ACS. It occurs in a minority of postmenopausal women accounting for approximately 1.7 to 2.2% of cases presenting with suspected acute coronary syndrome (ACS)¹. Our study is the first of its kind in Pakistan to diagnose the Takotsubo cardiomyopathy from acute anterior wall myocardial infarction by suspicion through ECG & confirming it on conventional coronary angiography.^{9,16}

The patients who were seen by us did not represent a particular demographic or social class, but the majority was from middle-class or lower-class backgrounds. 250 people with various forms of acute anterior wall myocardial infarction and determined the diagnostic accuracy of ECG.

We matched our study's findings to information that has been published internationally. A 2011 research found, Tamura et al² found out that ST-segment elevation >1 mm in >1 of leads V3 to V5 without ST-segment elevation >1mm in lead V1 identified Takotsubo cardiomyopathy with sensitivity of 74.2% and specificity of 80.6%. While, we found ECG sensitivity & specificity of 40.78% & 78.65% respectively using the same criteria. Though those investigators followed diagnosed patients of TC. Among all patients, their female-to-male ratio was 9.33:1; while in our study it was 1:2.90. There is gross difference in prevalence of acute anterior wall myocardial infarction in males whereas TC is prevalent predominantly in female gender.¹⁶⁻¹⁷

A retrospective study of 33 patients diagnosed with Takotsubo Cardiomyopathy, ECG criteria to diagnose TCM from AW-STEMI (AMI) in patients attended in less than 6 hours of development of symptom. Sensitivity of >91% and 96% specificity were observed when ECG criteria of absence of abnormal Q-waves, reciprocal changes, ST-segment elevation in lead V₁, and presence of ST-segment elevation in lead Avr were studied. But it was studied retrogradely in established patients of TCM & compared it with acute anterior wall myocardial infarction.¹⁶⁻¹⁹

Unfortunately, no such study, either through ECG or coronary angiography has not yet taken place in Pakistan. In Pakistan, our study is the first of its type to assess the diagnostic accuracy of ECG in differentiating TC from anterior wall myocardial infarction. Our study showed negative association of ST-elevation of > 1mm in ECG lead V₁ to differentiate TC from anterior wall myocardial infarction. Further studies should be done to probe into the diagnostic accuracy of ECG in differentiating TC from acute anterior wall myocardial infarction.

Limitation

- i. It was a retrospective study.
- ii. The study included a higher proportion of male gender because of increase incidence of anterior wall myocardial infarction in the male gender. Also due to social factors, many females don't turn up in emergencies in time to get treatment.
- iii. The current study just analyse only one lead of ECG to differentiate the TC from anterior wall myocardial infarction, other aspects of ECG & other diagnostic investigation may be investigated for diagnostic accuracy

CONCLUSION

In Pakistan, our study is the first of its type to assess the diagnostic accuracy of ECG in differentiating TC from anterior wall myocardial infarction. Our study showed negative association of ST-elevation of > 1mm in ECG lead V₁ to differentiate TC from anterior wall myocardial infarction. Further studies should be done to probe into the diagnostic accuracy of ECG in differentiating TC from acute anterior wall myocardial infarction.

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