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STUDY OF CORRELATION OF TOMBSTONE ECG PATTERN IN ACUTE ANTERIOR WALL MYOCARDIAL INFARCTION WITH RISK FACTORS AND IN HOSPITAL COMPLICATIONS

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Abstract
Background and objectives: The 'tombstoning' electrocardiographic (ECG) pattern is a particular kind of convex ST-segment change, as observed in some patients during the early stages of acute myocardial infarction (AMI). It has been suggested that this specific pattern of ECG changes following AMI predicts a poorer outcome in these patients.
The objective is to study the correlation 'tombstoning' electrocardiographic pattern in patients with first anterior wall acute myocardial infarction with risk factors and in hospital complications
Methods: This study investigated 73 patients with AMI whose ECGs were taken within 12 hours of onset of symptoms. The study population was divided into two groups based on the admission ECGs, 'tombstoning' vs. 'non tombstoning', and their clinical characteristics were compared.
Results: In this study population of 73 patients, 27 (36.9%) had a definite'tombstoning' pattern on their admission ECG. Compared with the 'non tombstoning' group, the significant differences in the 'tombstoning' group are as follows: infarction size is larger as evidenced by higher CK-MB levels (179.67 vs.90.57 IU); left ventricular ejection fraction is lower (40.56% vs. 47.86 %); preinfarct angina is lower (5 vs. 18.5 %), and in-hospital complications are higher.
Conclusion: This study shows that 'tombstoning' electrocardiographic patterns was associated with lower ejection fraction, left ventricular dysfunction and more in hospital complications. Pattern of the ST elevation has been shown to be a strong prediction factor for LV function in acute anterior MI.
Keywords: tombstone, Electrocardiogram, acute myocardial infarction, left ventricular ejection fraction

Introduction

Coronary artery disease (CAD) is one of the most common causes of morbidity and mortality in both low-income/middle-income and developed countries. The National Statistical Survey Organisation (NSSO) survey is the largest recent study on the prevalence of CAD in India. In its 60th NSSO survey (2004–2005), a total of 390 913 subjects were evaluated. The prevalence of CAD was found to be 7% in urban and 3% in the rural population.[(1-5).] ECG remains corner stone of diagnostic test for acute myocardial infarction and ST segment elevation is early sign of AMI and magnitude and extent of ST elevation indicates degree of myocardial wall injury .[(6)]

Wimalaratna[7] used the term tombstoning in 1993 to describe a characteristic shape of ST segment in patients of AMI. He reported that patients with tombstoning ECG pattern during the early stages of AMI had a higher rate of complications during the first 7 days of hospital stay. The complications being cardiogenic shock, arrhythmia, complete atrioventricular block, bundle branch block and a higher mortality rate.[7] The retrospective study was done by Huang and others in 1994 involving a large population of patients with AMI. Their statistical assessment confirmed Wimalaratna's findings.[8] In 2000 the same group published a study concluding that the patients with tombstoning pattern on admission ECG were associated with a high grade stenosis of the proximal Left Anterior Descending (LAD) artery and that it was predominantly seen in association with anteriorinfarction.[9]

Balci and Yesildag in their study of 106 patients in 2004 showed that CK - MB, the biochemical predictor of infarct size, was higher; left ventricular ejection fraction were lower; the incidence of preinfarct angina was significantly lower; systolic and diastolic blood pressures tended to be lower; and in-hospital complications like cardiogenic shock, ventricular tachycardia, fibrillation and death were higher in patients with the tombstoning electrocardiographic pattern compared with those without the pattern[(10)]

The objective is to study the correlation between the 'tombstoning' electrocardiographic pattern in patients with first anterior wall acute myocardial infarction with risk factors and in hospital complications.

Material and Methods

Study population:

The study was carried out on patients with first attack of anterior wall acute myocardial infarction admitted in

'Karnataka Institute of Medical Science,Hubli' between January 1st 2009 and December 31st 2010.

We included patients with first attack of anterior wall acute myocardial infarction were included in the study and were diagnosed with prolonged chest pain more than 30 minutes duration, diagnostic increase in CK-MB, evolution of serial ECG changes in two or more than two adjacent precordial leads suggesting acute myocardial infarction.

Patients were not included in the study if ECG is not recorded within 12 hours of onset of symptoms, ECG shows bundle branch block, Myocardial infarction other than Q-wave anteriorAMI, previous myocardial infarction, ECG having a mixed pattern.

Patients were informed regarding the aim of study and written consent was taken prior to inclusion into the study. During hospitalization, baseline characteristics, preinfarct angina, and coronary risk factors were recorded on standard forms. The admission electrocardiograms were obtained for future evaluation. 2 D echocardiography is done and Left ventricular ejection fractions were measured for all included patients. During hospitalization, death, cardiogenic shock ventricular arrhythmias (ventricular tachycardia/fibrillation), high-grade atrioventricular blocks (second- and third-degree atrioventricular block), and atrial fibrillation were recorded as in-hospital complications.

ECG features:

Standard 12-lead electrocardiograms were recorded at a rate of 25 mm/s and were calibrated at amplitude of 1.0 mV/10 mm. The isoelectrical line was determined by referring to the previous TP segment. All the electrocardiograms were divided into two groups according to the shape of the ST segment as (group 1) exhibiting tombstoning pattern and (group 2) not exhibiting tombstoning pattern. The definition of tombstoning pattern used by Guo et al, who modified Wimalaratana's definition, was used.

1. The R wave is either absent, or if present, its duration is less than 0.04s with minimal amplitude and there is no trough following the Rwave.
2. The ST segment is convex upwards and merges with the descending limb of the R wave or the ascending limb of the QRS/QRwave.
3. The peak of the convex ST segment is higher than whatever remains of the Rwave.
4. The convex ST segment merges with the ascending limb of the following Twave.

Statistical analysis:

Continuous data were expressed as mean +/- standard deviation and were compared by the independent t-test. Categorical data were expressed as percentages and were compared by the chi-square test and Fischer's exact test. A p-value < 0.05 was considered significant.

Results:

A total of two hundred and sixty patients of acute myocardial infarction were admitted in our hospital between Jan 2009 and Dec 31st 2010; of these 182 were cases of acute anterior wall myocardial infarction.92 cases were excluded as they met various exclusion criteria. 90 patients with first acute anterior wall myocardial infarction satisfied all the inclusion criteria. 17 patients were not included as they did not give consent for the study.

Out of the study population of 73 patients, typical tombstoning pattern in all the anterior wall ECG leads was seen in 27(36.9863%) patients. The remaining 46(63.01%) patients did not exhibit tombstoning ECG patterns.

During hospital stay complications of acute myocardial infarction like ventricular arrhythmias (ventricular tachycardia/fibrillation), high-grade atrioventricular blocks (second- and third-degree atrioventricular block), and atrial fibrillation were recorded as in-hospital complications.

Demographic profile and risk factors

There were no significant differences between the 2 groups with respect to sex and age.Preinfarct angina is more common in patients with anterior wall myocardial infarction of nontombstone pattern than in patients with tombstone ECG pattern The p value being<0.05 and is statistically significant.There was no significant difference between the two groups with respect to history of smoking. There was no significant difference between the two groups with respect to history of hypertension and level of blood sugar control and duration of diabetes. So as the BMI increases, significant no of patients in our study presented with tombstone ECG pattern MI (p value is 0.016)

Clinical and laboratory parameters

In our study patients with tombstone ECG pattern have significantly lower systolic blood pressure and it shows low systolic blood pressure is a presenting feature of acute anterior wall MI with tombstone ECG pattern. Current study showed patients with tombstone ECG pattern have significantly lower diastolic blood pressure and it shows low diastolic blood pressure is presenting feature of acute anterior wall MI with tombstone ECG pattern

Though mean total cholesterol level in patients with tombstone pattern is higher than than the same in patients with non tombstone pattern statistical analysis showed there is no significant difference between the two groups There is no significant difference between the two groups with respect to serum HDL levels but we found significantly

higher levels of LDL levels in patients of AMI with TOMB-ST pattern compared non TOMB-ST elevation MI

Patients with tombstone ECG pattern presented with raised levels of CK -MB, the biochemical predictor of infarct size, more than that of patients with non tombstone ECG pattern. The difference between the two groups is statistically significant.

Table 1: Showing demographic profile, and risk factors

	group	MEAN	SD	P VALUE
Age	TS	56.74	12.221	0.293
	NTS	54.18	10.032	
MALE	TS	21		0.785
	NTS	34		
FEMALE	TS	6		
	NTS	12		
SMOKING	TS	17(62.96%)		0.225
	NTS	21(45.65%)		
DIABETES	TS	12(44%)		0.204
	NTS	13(28.26)		
BMI	TS	26.1196	2.99	0.016
	NTS	24.4489	2.67	
SBP	TS	113.069	22.717	0.000
	NTS	118.78	20.944	
DBP	TS	71.92	11.193	0.001
	NTS	75.61	13.822	
TC	TS	223.28	45.344	0.119
	NTS	206.78	43.508	
HDL	TS	43.84	9.677	0.671
	NTS	42.63	7.487	
LDL	TS	151.16	43.109	0.033
	NTS	130.67	33.896	
CK	TS	179.69	68.022	0.000
	NTS	256.50	28.991	
EF	TS	40.56	5.033	0.000
	NTS	47.95	6.935	

(SD-standard deviation, TS –tombstone stsegment, NTS-Non tombstone ST elevation, BMI –Body mass index, SBP-systolic blood pressure, DBP- diastolic blood pressure, TC-total cholesterol, HDL –high density lipid, LDL –low density lipid, CK-creatine kinase, EF-ejection fraction)

Treatment aspects and in hospital course

There is no significant difference between the two groups regarding treatment recieved by patients as per ICCU protocol including thrombolysis .Patients with tombstone ECG pattern myocardial infarction have significantly low ejection fraction (mean is 40.56%) as compared to that of patients with nontombstone pattern myocardial infarction. Significantly higher number of patients with tombstone ECG pattern had developed cardiogenic shock as a in hospital complication as compared to patients with non tombstone ECG pattern.Incidence of VT in patients with non tombstone ECG pattern myocardial infarction is only 4.3% as compared to 29.60% in patients with tombstone pattern myocardial infarction .Fischer's exact test applied to this showed that p value is 0.01. So difference is statistically significant.Incidence of Ventricular fibrillation is around 2.12 % in patients having non tombstone pattern MIbutis significantly high (11.1%) in patients with tombstone .ECG pattern MI. Fischer's exact test showed there is significant difference between the two groups.

Out of 73 patients with anterior wall myocardial infarction, 2 deaths occurred out of 46 patients with non tombstone pattern MI, 6 deaths occurred out of 27 patients of tombstone ECG pattern MI. Statistical analysis by Fischer's exact test showed the difference is statistically significant where P value is 0.045(according to chi square , p value is 0.018 <0.05)

Table 2: Showing in hospital complications

PARAMETERS	GROUP	NUMBER	P VALUE
PREINFARCT ANGINA	TS	5	0.014
	NTS	22	
THROMBOLYSIS	TS	24	0.204
	NTS	36	
EJECTIN FRACTION	TS	40.56	0.000
	NTS	47.95	
CARDIOGENIC SHOCK	TS	10	0.001
	NTS	6	
VT	TS	8	0.001
	NTS	2	
VF	TS	3	0.009
	NTS	1	
DEATH	TS	6	0.018
	NTS	2	

(TS-tombstone ,NTS –Non tombstone , VT –ventricular tachycardia, VF –ventricular fibrillation)

Discussion

Many studies have investigated application of 12-lead ECG for risk stratification. Various ECG variables have been studied such as terminal QRS (e.g.: Sclarovsky-Bimbaumscore), ST segment (e.g.: ST), T wave (e.g.: T wave inversion), and initial QRS developing during ischemia (e.g.: Selvester QRS score). Distortion of the terminal portion of QRS complex (grade III ischemia) is one of the ECG signs that are used to determine patients under high risk. Main criteria applied for terminal QRS distortion include disappearance of S wave in leads with RS morphology and a J point elevation above the lower half of R wave in leads with QR morphology. As patient with grade III ischemia demonstrate poor prognosis and larger final infarct size, they benefit less from thrombolytic treatment and primary angioplasty .Grade III ischemia and TOMB-STEMI display similarities with respect to poor prognosis and less efficient reperfusion therapy[11].

TOMB-STEMI display similarities with respect to poor prognosis and less efficient reperfusion therapy. Morphological changes occurring in the ECG are also included in the risk stratification analysis. Regardless of the total amplitude of the ST- segment elevation, tombstoning pattern has been proposed to be associated with higher mortality and ST elevation pattern has been reported to be a more important factor than quantitative changes (e.g.: ST) in risk stratification. Pattern of the ST elevation has been shown to be a strong prediction factor in acute MI.

While concave ST elevation is associated with perfect LV function, convex ST elevation is associated with poor LV function .Along with the quantitative changes in ST segment elevation, inclusion of morphologic alteration in risk stratification may contribute in obtaining more consistentresults.[12.]

The tombstoning ECG pattern is a unique ST segment change which can be used as a cardiac marker in AMI. This is observed in some patients during the early stages of AMI. The term tombstoning has been used by doctors to describe a certain shape of ST segment in the electrocardiograms of patients with AMI. This provocative term was often being used to communicate to colleagues a grave prognosis of the patient in question.[7]

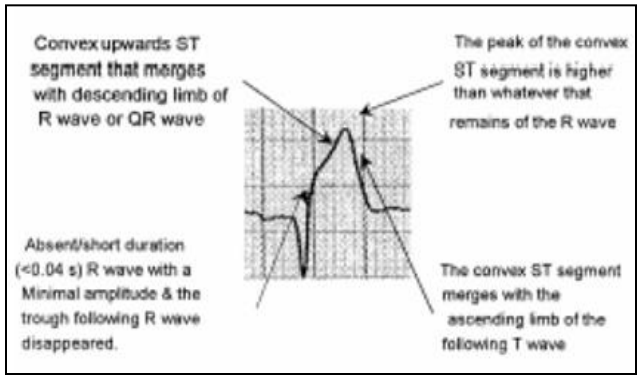

Figure 1: ECG showing Tombstone pattern of ST Elevation

Wimalaratna in a published letter has described tombstoning pattern in 1993. He used the term tombstoning to describe a characteristic shape of ST segment in patients of AMI. The ST segment is convex up wards and has a fast rise time, and these changes are seen in all the leads that have ST segment elevations. The peak of the convex ST segment is often higher than the preceding R wave, which is of a short duration (often less than 0.04s) and small in amplitude. The ST segment merges with the ascending limb of the following T wave and therefore T wave cannot be identified separately. Inversion of the T wave is not noted in tombstoning tracings. He reported that patients with tombstoning ECG pattern during the early stages of AMI had a higher rate of complications during the first 7 days of hospital stay. The complications noted were cardiogenic shock, arrhythmia, complete atrioventricular and bundle branch block and a higher mortality rate. His study of 63 patients supported the notion that tombstoning may be a sign of bad prognosis in patients with acute myocardial infarction and the awareness of this variation could have helped physicians to save lives by prompt action. It could be argued that tombstoning is merely the presentation of a hyper acute state or early change of the ST segment after acute myocardial infarction. However the fact remains that the patients with these specific ST changes at admission had a poor prognosis.[7]The mechanism of this particular ST segment change is difficult to explain. It is likely to represent extensive and rapid myocardial damage after the ischemicepisode.

ThetombstoningpatternmayactuallybeaprolongedRwave.[14] Morphet JA from Ontario also described this unique ECG marker termed tombstoning by Wimalaratana. He underlined the prognostic potential of tombstoning ECG pattern and he suggested that it be used as a cardiac marker for risk stratification along with Troponin T.[15]In 1994 a retrospective study was done by Huang and others involving a large population of patients with AMI. The statistical assessment of the study confirmed Wimalaratna findings. In their study of 605 patients they concludedthat patients with tombstoning of ST segment after AMI tend to have reduced LV function and higher mortality. Tombstoning of the ST segment was becoming more recognized as a grave prognostic sign in AMI.[8]

Because the tombstoning ECG is predictive of such a poor outcome, an up-to-date presentation was made at NASPE in Toronto, Canada in 1999 as to the cause, associations and implications of this specific pattern of ECG changes.[15]

Epidemiology and risk factors

There are only a few reports available on the effects of the shape of ST segment elevation on the clinical outcome or prognosis in patients with STEMI. Wimalaratna first reported a typical and rapidly progressing convex elevation of ST segment reminiscent of a tombstone. This shape of ST segment was associated with an increased rate of in-hospital complications. TOMB-ST signs were observed in the study ofWimalaratna[7] in 10% of patients with acute MI, whereas Guo et al[9] reported it in 19% of subjects, and Balci and Yesildag[10] – in 22% of patients with acute Ant MI. Piotr kukla et al studied around 207 patients out of which 55(26.6%) were tombstone pattern. Among them 39% were of anterior wall MI. The present study was conducted in 73 patients who were selected from the cases admitted in ICCU, Karnataka Institute of Medical Sciences, Hubli. Out of which 27(36.98%) patients exhibited tombstone ECG pattern and 46 (63.01%) patients had nontombstone pattern. Incidence in our study is comparable with study done by Piotr kuklaetal.

In present study mean age of patients of myocardial infarction presented with tombstone ECG pattern is 56.54 compared to 54.18 in patients with non-tombstone pattern with no difference between age groups. Age distribution in our study is comparable to Balci et al (mean age is 59), Guo et al (59.8), Piotr kukla et al (68.9).In all three studies age distribution is not significant and mean age difference between the two groups is <5 years. The pattern of age distribution shows more incidence of tombstone pattern occurs in patients aged >60 years as

evident by our study which correlates with increased incidence of mortality because of elderly age.

The table shows more no of diabetic and hypertensive patients (44.44% and 55.55% respectively) in present study compared to other studies Balci et al (25%and 34% respectively), Guo et al (12.5%and 20.8% respectively), Piotr kukla et al (22.4%), have presented with tombstone ECG pattern MI. Statistical analysis showed no significance is attributable to these factors as in other three studies.

Smoking is well known risk factor for coronary event. In our study there was no significant difference between the two groups. 62.96% of patients with tombstone pattern were smokers compared to 45.65% of patients with non tombstone pattern. The percentage of smokers among our present study population is comparable to study done by Balci et al (62%).

History of preinfarct angina was significantly lower in patients with tombstone ECG pattern (18.5%) compared to those without tombstone pattern (47.8%). History of preinfarct angina were significantly lower in patients with tombstone pattern studied by Balci et al (39%), and Guo et al (12.5). Several studies were consistently shown that patients with anterior wall MI proceeded by preinfarct angina have a smaller infarct and better in-hospital outcome than patients without preinfarct angina. At least three mechanisms can explain these differences between infarctions that are preceded by angina pectoris and those that are not: 1) coronary collaterals 2) reperfusion rate and 3) ischaemic preconditioning. The myocardium protective effects of preinfarct angina do not appear in patients with tombstone ECG pattern. Therefore the lack of myocardium protective effects of preinfarct angina is likely to increase the ischemic damage due to MI and causes the fast rise time and convex ST segment that is so characteristic of tombstoning.

Biochemical parameters:

Our study shows that there is significant difference between the fasting blood levels of LDL between the two groups (150.33+/-40 in patients with tombstone pattern vs130.67+/-33.89 in non-tombstone group).There were no significant differences between the two groups in terms of BMI, HDL, and Total cholesterol. Other studies also showed no relationship between these risk factors and ECGpattern.

In our study it is evident that mean blood levels of CK-MB are higher in patients with tombstone ECG pattern than that of patients without tombstone pattern. These changes indicated extensive and rapid damage to the myocardiumwhich results in low LV ejection fraction. Mean blood levels of CK-MB are 179.67 vs 90.57 in present study, 397vs 290 in study done by Balci et al,1598vs 1575(peak CK) in study by Piotr Kuklaetal.

In hospital complications

Mortality rate was significantly higher in the TOMB-ST patients compared to the non-TOMB-ST ones(.22.2vs4.3).Other in-hospital complications such as cardiogenic shock ,VT, VF, and AV block occurred more frequently in TOMB-ST patients.(37.03vs13.03, 19.6vs4.3, 11.1vs2.12, 18.5vs4.3 respectively).Results in terms of in-hospital complications is similar to studies done by others which are depicted in table 3.

Table 3: Comparing demographic pattern, risk factors and in hospital events in present study to other studies

	Present study	Wimalartna	Balci et al	Guo et al	Piotr kukla et al	Tomcsanyi et al
Study population	73	63	106	124	207	
Male vs female(percentage)	77.77%vs22.22	NA	74vs26	91.6vs8.40	61.8vs29.47	NA
AGE (mean) TS NTS	56.74 54.18	NA	59 58	59.8 56	68.9 66.2	NA
NO of TS pattern	27(36.9%)	6(10)	23(21.6)	24(19.35)	55(26.6)	NA
Diabetes	12(44.4%)	NA	8(25%)	59(12.5%)	13(22.4%)	NA
Hypertension	15(55.5%)	NA	11(34%)	3(20.8%)	NA	NA
smoking	17	NA	20	NA	NA	NA
BMI TS NTS	26.11 24.45	NA	NA	NA	NA	NA
Total Cholesterol TS NTS	233.48 206.78	NA	NA	NA	NA	NA
LDL TS NTS	150.33 130.67	NA	NA	NA	NA	NA
HDL TS NTS	43.48 43.63	NA	NA	NA	NA	NA
Ejection fraction	40.56vs47.86	NA	42vs51	NA	40.9vs46.9	NA
PREINFARCT ANGINA	18.5%		39%	12.5%	NA	NA
MEAN CK-MB(TS vs non TS)	197vs91	NA	397vs290	NA	1598vs1575	NA
Cardiogenic Shock	37.03 VS 13.03		22 VS 2	21.8vs 12.3	9vs3	9vs6
VT	19.6vs4.3		17vs2	NA	9vs6	9vs3
VF	11.1vs2.12		30vs5	NA	18.1vs6.4	
AV BLOCK	18.5vs4.3		13 vs10		13vs6	
DEATH	22.2vs4.3		26vs2	38vs10	38vs10	13vs6

(SD-standard deviation, TS –tombstone st segment, NTS-Non tombstone ST elevation, BMI –Body mass index, SBP-systolic blood pressure, DBP- diastolic blood pressure, TC-total cholesterol, HDL –high density lipid, LDL –low density lipid, CK-creatine kinase, EF-ejection fraction, AV Block-atrioventricular block, NA- not available, vs-versus)

Conclusions:

From present study following conclusions are drawn. TOMB-ST pattern in ECG was observed in 39% of anterior wall MIpatients. These patients with TOMB-ST elevation were associated with lower ejection fraction. Pattern of the ST elevation has been shown to be a strong prediction factor for LV function in acute MI.TOMB-STONE ST elevation is associated with poor LV function.Tombstoning' which is an easily ascertainable ECG pattern is related to larger infarct size as indicated by higher CK-MB, and increased in-hospital complications, thus providing a rationale for early and aggressive management of suchpatients.

Limitations of study:

Our study included patients with acute myocardial infarction underwent only thrombolysis as initial therapy. Currently primary percutaneous coronary interventions are preferred[18]. Our study not compared Tombstone elevations with coronary angiogram and blood flow to myocardium and extent of occlusion of arteries with patients non tomb-ST elevation acute MI.

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