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PRESENCE OF UPRIGHT T WAVE IN V1 AND ITS ASSOCIATION WITH THE CORONARY ARTERY DISEASE

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ABSTRACT

Background: We aimed to determine the association of upright T wave in lead V1 and stenosis of coronary artery branches in patients who underwent coronary angiography at our center and had normal electrocardiogram. ***Methods:*** We retrospectively reviewed the clinical and coronary angiography data of patients who had normal electrocardiogram. Presence of coronary artery disease was compared between patients with and without upright T wave in lead V1 as well as other clinical and angiographic parameters. ***Results:*** Data of a total of 100 patients with upright T wave in lead V1 was compared with 100 patients with completely normal electrocardiograms. Frequency of males and CAD patients were higher in the upright T wave group. However, the groups did not differ statistically about the cardiovascular risk factors. Based on the multivariable regression model and after adjustment for confounding factors (i.e. gender, dyslipidemia and smoking), presence of upright T wave in the V1 lead could predict the presence of coronary artery disease (Odds ratio=3.30, 95% CI:1.736.29; P<0.001). ***Conclusion:*** We suggest that the use of electrocardiogram, particularly the presence of upright T wave in lead V1 could help to early diagnosis and treatment of CAD in patient's chest pain.

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INTRODUCTION

Cardiovascular disease is still imposing a great burden on the health care system in every country and many people die due to coronary artery disease every year (Ebrahimi *et al.,* 2011; Sarraf-Zadegan *et al.,* 1999). Therefore, early recognition and treatment of CAD can help much to reduce the mortality and morbidity and thereby increase the life expectancy (Shafiee and van Bodegom, 2012). Several non-invasive methods have been introduced for the identification of CAD but the conventional coronary angiography is still the gold standard. Most of these non-invasive methods have a low sensitivity and are mostly expensive. Therefore, application of a non-invasive cheap test can help much to screen people for CAD. Electrocardiography is the initial test for screening CAD (Blackburn *et al.,* 1970; Rose *et al.,* 1978). So, recognition of specific changes in the ECG pattern suggestive of undiagnosed CAD can assist the clinicians in asymptomatic patients (Kreger *et al.,* 1987). Changes of the T wave are associated with myocardial ischemia (Savage *et al.,* 1977). On the other hand, upright T wave was associated with right ventricular involvement in posteroinferior acute myocardial infarction (AMI) (Kataoka, 1994). However, its relationship with CAD is still unidentified. In the present study, we aimed to identify the association of upright T wave in V1 lead and the presence of CAD in patients who had normal ECG pattern and underwent coronary angiography at our center.

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METHODS

In this cross sectional study, data of 4000 patients who underwent coronary angiography at our center was reviewed based on our study criteria. The criteria of inclusion were age>18 years, and normal ECG. The exclusion criteria included history of cardiac surgery or intervention, history of cardiac arrhythmia or catheter ablation, having pacemaker or other cardiac devices, severe valvular disease, inverted T wave in leads after V1, inter ventricular conduction delay, left ventricular hypertrophy and unreadable ECG. A written informed consent was obtained from the participants at the time of admission as the routine of our center that their clinical data would be used anonymously for research purposes.

Based on the shape of the T wave, patients were then divided into with and without T wave groups and the results of the coronary angiography as well as other study variables were compared between the two groups.

Statistical analysis

Continuous variables were described with mean and standard deviation (SD) or with median and 25th and 75th percentiles for skewed data; and were compared between patients with and without upright T wave using student's t or Mann-Whitney U test where appropriate. Categorical variables were expressed as frequency and percentage and were compared among groups using chi-square test.

Table1. General and clinical characteristics of the study groups

Characteristic	Normal ECG (n=100)	Upright TV1 ECG (n=100)	P-value*
Age	55.4±9.3	57.2±10.8	0.219
Male gender	45†	84	<0.00
CAD	26	62	<0.001
Diabetes Mellitus	27	26	0.877
Hypertension	35	27	0.221
Dyslipidemia	48	36	0.086
Smoking	15	23	0.149
Family history of CAD	14	14	0.999
Admission			
Emergency	14	14	
Elective	86	86	
Acute chest pain	14	18	0.44
Exertional chest pain	58	53	0.477
Dyspnea on effort	15	17	0.7
No symptom	16	22	0.279
Result of angiography			<0.001
Normal/minimal	74	38	
Single vessel disease	14	31	
2-vessel disease	9	12	
3-vessel disease	3	19	
Left anterior descending	21/26 (80.7) 5	2/62 (83.62)	<0.001
Artery			
Left circumflex artery	8/26 (30.7)	30/62 (48.3)	<0.001
Right coronary artery	12/26 (46.1)	30/62 (48.3)	0.002

* P-value<0.05 was considered as statistically significant. † Numbers represent both the frequency and percentage, CAD: Coronary artery disease

The study protocol was approved by the local Institutional Committee of Medical Ethics and the Research Board of Tehran University of Medical Sciences. This study conforms to the principles outlined in the Declaration of Helsinki. Based on the study criteria, file of the patients was reviewed and their demographic and clinical data including age, gender, height, weight, history of previous disease and cardiovascular risk factors as well as the laboratory data were retrieved from the databank of Tehran Heart Center. Also, the results of the coronary angiography, including the name of the vessel and degree of stenosis were retrieved from the data bank of angiography for each patient. The presence of premature CAD was evaluated by conventional angiography at the catheterization laboratory of Tehran Heart Center under local anesthesia by an expert cardiologist. The angiography was performed by standard Judkins technique using a quantitative coronary angiographic system (Just, 1977). Significant atherosclerotic coronary artery lesion was defined according to the guideline of the American College of Cardiology/ American Heart Association as a 50% or more narrowing of the lumen diameter in at least one major coronary artery (Smith *et al.,* 2006). The electrocardiograms, particularly the characteristics of the T wave in V1, V6, I and III leads were interpreted by two cardiologists who were unaware of the study protocol from the patients' files and the results were recorded.

Variables which were simultaneously associated with CAD and upright T wave with p-values less than 0.2 were considered as potential confounders. The association of upright T wave with CAD was adjusted for detected possible confounders applying logistic regression model. The effect of upright T wave on occurrence of CAD was reported through odds ratio (OR) with 95% confidence interval (CI). All statistical analyses were performed using IBM SPSS statistics for Windows version 22.0 (Armonk, NY: IBM Corp.).

RESULTS

In this study, 100 patients with upright T wave in V1 lead and 100 patients with normal ECG were compared. In the upright T wave group, frequency of males and frequency of patients with CAD was significantly more than the normal ECG group. Other study variables, particularly the frequency of cardio-vascular risk factors was not different between the groups. Comparison of the general characteristics of the study groups are shown in Table 1. Base on the univariate regression model, presence of upright T wave could predict the presence of CAD (OR=4.64, 95% CI: 2.54-8.48; P<0.001). In the multivariable regression model and after adjustment for confounding variables (including gender, dyslipidemia, and smoking) presence of upright T wave in V1 lead could still predict CAD (OR=3.30, 95% CI: 1.73-6.29; P<0.001). In 100 patients with

upright TV1, 70 patients were treated medically and 30 patients underwent revascularization, either by coronary artery bypass graft (n=8) or percutaneous coronary intervention (n=22). Post-procedural ECG showed that in patients who had CAD and underwent revascularization, in 13 patients upright T wave converted to flat or inverted T wave in V1 lead.

DISCUSSION

This study showed that presence of upright T wave in V1 lead could help to identify CAD. This finding could help to prediction and early diagnosis of CAD in patients with ischemic cardiac symptoms. T wave in superficial ECG shows the ventricular repolarization and conditions such as myocardial ischemia or infarction influence on the repolari-zation sequence and make changes in T wave (Manno *et al.,* 1983; Robbins *et al.,* 1988; Sclarovsky *et al.,* 1988). Myocardial ischemia can induce electro physiologic changes in action potential and cause the difference between normal and ischemic regions and between the epicardium and the endocardium (Lukas and Antzelevitch, 1993). These slight changes can be measured by superficial ECG (Nash *et al.,* 2003). Accordingly, one study reported a 33% frequency for subclinical myocardial ischemia and the related repolarization difference was 16% (Al-Zaiti *et al.,* 2011).

Results of a study showed the association of upright T wave in v1 lead and ischemia due to proximal right coronary artery in patients with postero-inferior MI (Kataoka, 1994). Based on their findings, presence of upright T wave in these patients could represent the ischemia of the right ventricle. In another study, Upright T wave in v1 was associated with left circumflex artery disease (Manno *et al.,* 1983). In patients who had single vessel disease, presence of upright T wave in V1 was more likely to be associated with left circumflex artery stenosis than the left anterior descending artery and the authors concluded that this condition is present with ischemia in the posterior region. Another report showed that almost half of the patients with posterior MI—as detected by autopsy or ECG-had upright T wave (Perloff, 1964). It should be noted that the capability of ECG for predicting the presence of CAD in the absence of apparent ischemia or myocardial damage is limited. Therefore, consideration of upright T wave in V1 lead can help to diagnose CAD (Savage *et al.,* 1977; Tranchesi *et al.,* 1961; Howard *et al.,* 1976; Horan *et al.,* 1971; Pappas *et al.,* 1958). It has been shown that the addition of this finding as a diagnostic item can increase the specificity and diagnostic accuracy for the presence of CAD by ECG, despite the reduction in sensitivity (Arkin *et al.,* 1979). T wave taller than 0.15 mV has also been reported as a predicting factor for CAD in middle age and elderly male patients (Dekker *et al.,* 1995). On the other hand, taller T wave in V1 in comparison with V6 has been proposed as an abnormal ECG finding. Nonetheless, this characteristic was only observed in less than 1% of hospitalized patients: the frequency of CAD, systemic hypertension, and pulmonary disease is higher in these patients (Weyn and Marriott, 1962).

It seems that hypertension is the most frequent reason for Tv1>TV6 due to left ventricular hypertrophy. Based on a case report, Upright T wave in V1 and TV1>Tv6 were the only signs of CAD in an elderly patient. Therefore, positive T wave in V1 should be considered as an alarming sign for CAD in asymptomatic or suspicious patients. Based on our findings and the body of literature, slight changes in the ECG, such as upright T wave in V1 can be used as a good screening toll in some patients with ischemic symptoms. Study limitations our center is a tertiary cardiovascular center and most patients are referred from other hospitals. So, there is a probability that the results of our study could be different from the general population.

Conclusion

Overall, this study showed that utilization of ECG as a screening tool by considering the changes of T wave in precordial leads, particularly Upright T wave in V1 lead in patient's chest pain could predict the presence of CAD and early diagnosis and treatment. Future studies could focus on circadian changes of the T wave and its association with the degree of stenosis and location of the atherosclerotic vessel in CAD patients.

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Conflict of interest

The authors have no conflict of interest to declare.

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