

## ARTICLE ORIGINAL/ORIGINAL ARTICLE

# SIGNIFICANCE OF UPRIGHT T WAVES IN PRECORDIAL LEAD V1 AS TO ITS CORRELATION WITH CORONARY ARTERY DISEASE AND IN PARTICULAR THE CIRCUMFLEX CORONARY ARTERY

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Joyce KHARMA<sup>1</sup>, Anthony MATTA<sup>2\*</sup>, Rachoin RACHOIN<sup>3</sup>, Alexandre KHARMA<sup>2,4</sup>

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**ABSTRACT • Purpose:** The T wave in precordial lead V1 is normally inverted in normal adults. The significance of an upright T wave in precordial lead V1 as to the presence of coronary artery disease is controversial and not well studied in the literature. Our purpose is to show the relation between an upright T wave in V1 and the presence of coronary artery disease and specifically that of the circumflex. **Material and methods:** We studied, retrospectively, 624 consecutive patients referred for cardiac catheterization with normal electrocardiograms excluding patients with acute coronary syndromes, bundle branch blocks, left ventricular hypertrophy, intraventricular conduction delays, pacemakers, ST-T changes, significant valvular heart disease, cardiomyopathies and metabolic disorders. Significant coronary artery stenosis was considered when the stenosis was > 70%; normal or nonsignificant coronary artery stenosis was considered when the coronary stenosis was < 70% (all patients had < 50% coronary stenosis). The ECG's and coronary arteriographies were reviewed. The 2x2 chi-square was used for statistical analysis. **Results:** Out of the 624 patients, 380 (60.89%) had normal coronary arteries out of which only 17 (4.47%) had an upright T wave in V1, 244 (39.11%) had significant coronary artery disease out of which 137 (56.14%) had positive T wave in V1, significantly more than the normal population with a *p* value < 0.0001. A total of 142 patients had significant circumflex stenosis out of whom 128 (90.1%) had a positive T wave in V1; a total of 482 patients had no significant circumflex stenosis, out of whom only 26 (5.39%) had a positive T wave in V1, the difference was highly significant with a *p* value < 0.00001 as to the presence of a T upright in V1 in patients with significant circumflex stenosis. This significance was maintained when excluding the patients with diabetes mellitus. **Conclusion:** An upright T wave in V1 is significantly related to the presence of significant coronary artery stenosis and specifically the circumflex coronary artery.

Keywords: upright T wave in precordial lead V1; coronary artery disease; circumflex coronary artery; diabetes mellitus

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**RÉSUMÉ • Objectif:** L'onde T dans la dérivation précordiale V1 est normalement négative chez les adultes. L'importance d'une onde T positive dans cette dérivation quant à la présence de maladie coronarienne est controversée et peu étudiée dans la littérature. Notre objectif est de montrer la relation entre une onde T positive en V1 et la présence de maladie coronarienne et en particulier celle de l'artère circonflexe (Cx). **Méthodes:** Nous avons étudié rétrospectivement 624 malades consécutifs référés pour coronarographie avec des électrocardiogrammes (ECG) normaux avec les exclusions suivantes: blocs de branches, hypertrophie ventriculaire gauche, problèmes de conductions intraventriculaires, stimulateurs automatiques, maladies valvulaires, cardiomyopathies et troubles métaboliques et électrolytiques. Les sténoses coronariennes étaient considérées significatives si > 70%, et non significatives si < 70% (toutes les sténoses non significatives étaient < 50% chez les patients inclus). Les ECGs et les coronarographies étaient revus. Le 2x2 chi-square a été utilisé pour l'analyse statistique. **Résultats:** Des 624 patients, 380 (60,89%) avaient des coronaires sans sténoses significatives, dont 17 (4,47%) avaient une onde T positive en V1, 244 avaient des sténoses significatives des coronaires dont 137 (56,14%) avec une onde T positive en V1, une différence significative (*p* < 0,0001) les comparant aux patients sans sténoses significatives. Cent quarante-deux patients avaient des sténoses significatives de la Cx dont 128 (90,1%) avec l'onde T positive en V1. Seulement 26 (5,39%) des 482 malades sans sténoses significatives de la Cx avaient l'onde T positive en V1, une différence très significative avec un *p* < 0,00001 en faveur de la présence d'une onde T positive en V1 et sténose de la Cx. Cette relation fut maintenue quand les patients diabétiques ont été exclus. **Conclusion:** Une onde T positive en V1 est significativement reliée à la présence de sténoses coronariennes significatives et spécifiquement celle de la Cx.

Mots-clés: onde T positive en V1; sténoses coronariennes; circonflexe; diabète

<sup>1</sup>Faculty of Medical Sciences, Holy Spirit University of Kaslik/USEK, Kaslik, Lebanon.

<sup>2</sup>Cardiology Department, Notre-Dame de Secours University Hospital (NDSUH), Jbeil; USEK University.

<sup>3</sup>Cardiac Echo Unit, NDSUH.

<sup>4</sup>Faculty of Medicine, USEK.

\*Corresponding author: *Anthony Matta, MD.*  
e-mail: dr.anthonymatta@hotmail.com

## INTRODUCTION

The electrocardiogram, a simple, noninvasive test, remains the cornerstone in the diagnosis of various cardiac conditions including coronary artery disease (CAD). The T wave represents the repolarization of the ventricles and could be affected by multiple factors including myocardial ischemia and infarction [1].

These changes could however be nonspecific and related to other factors than coronary abnormalities [2].

The T wave in V1 is the net result of the anterior and posterior repolarization forces [3].

A positive T in V1 has been described in normal subjects, in relation to posterior ventricular abnormalities and infarction, as well as in young adults [4].

Very few studies have looked at the significance of an upright T wave in V1 and the presence of significant CAD, in patients with otherwise normal electrocardiograms or not in the acute setting. They studied a relatively small number of patients, showed an association with CAD, and conflicting results relating to the coronary artery involved, the circumflex being in common [5,6].

The aim of our study is to establish the relationship between an upright T wave in V1 and the presence of CAD and in particular that of the circumflex.

## METHODS

### Patients selection

We reviewed retrospectively the electrocardiograms (ECGs) of 1205 consecutive patients undergoing diagnostic cardiac catheterization; 624 patients satisfied our inclusion criteria.

Excluded were the patients with acute coronary syndromes, bundle branch blocks, left ventricular hypertrophy, intraventricular conduction delays, pacemakers, ST-T changes, significant valvular heart disease, cardiomyopathies and metabolic disorders.

Significant coronary artery disease was considered when the stenosis was > 70%; normal or nonsignificant coronary artery was considered when the coronary stenosis was < 70% (all patients were < 50%). Stenosis 70-50% was defined according to diameter percentage. Patients with normal or nonsignificant CAD will be referred to as normal.

Any positive deflection of the T in V1 was considered positive, and negative deflection was considered negative; no isoelectric T waves were in the included population.

There were 443 males and 181 females, with a mean of 58.92 and a standard deviation of 11.67.

Three hundred and eighty (60.89%) patients had normal or nonsignificant coronary artery disease and 244 (39.11%) had significant coronary disease.

The position of V1 is standardized according to the recognized criteria [2]. Training sessions for all personnel performing the electrocardiograms were carried out more than once prior to the date of the start of our data collection.

### Statistics

Statistical analysis was performed for the 2x2 analysis using the chi-square test ( $\chi^2$ ) with significance considered for values less than 0.05.

## RESULTS

The total number was 624, there were 443 males and 181 females, with a mean age of 58.92 and a standard deviation of 11.67.

Three hundred and eighty (60.89%) patients had normal or nonsignificant coronary artery disease and 244 (39.11%) had significant coronary disease.

The presence of a positive T wave in V1 was present in 137 (56.14%) patients with significant CAD as opposed to only 17 (4.47%) in patients with nonsignificant CAD. This was highly significant with a *p*-value of less than 0.0001 and a specificity (Sp) of 95.52%, a sensitivity (Se) of 56.14%, a positive predictive value (PPV) of 88.96% and a negative predictive value (NPV) of 77.23% (Table I).

When examining the patients with significant stenosis at the level of the circumflex coronary artery (Cx) compared to patients without significant stenosis of the Cx, 128 (90.1%) with significant Cx disease had positive T waves as compared to 26 (5.39%) in patients without Cx disease; this was very highly significant with a *p*-value < 0.00001, a Se of 90.14%, a Sp of 94.60%, a PPV of 83.12% and a NPV of 97.02% (Table II).

We excluded diabetic patients to see if this correlation is maintained in non diabetics (Table III). There was a total of 514 non diabetics; 96 (18.6%) had Cx disease, with the presence of a positive T wave in V1 significantly more in Cx as compared to the non-Cx group with a *p* < 0.00001, Se 91.66%, Sp 95.93%, PPV 83.8% and NPV 98.04% (Table IV).

## DISCUSSION

Our findings show that in patients with normal ECGs referred for coronary arteriography an upright T wave in V1 is significantly more in patients with significant CAD, and in particularly those with significant stenosis of the Cx. The results being highly significant for Cx disease lose their significance when significant Cx is excluded.

Only 4.47% of normals in our study had positive T wave in V1. The literature varies from 9% to 38.7% [4-6]. Perloff reviewed 250 normal ECGs and found 20% incidence of upright T wave in V1, however there was no correlation with coronary arteriography. The others had a relatively smaller number of patients with variable inclusion and exclusion criteria [4].

Manno *et al.* who studied only 218 consecutive patients, had less strict exclusion criteria, only 34 (15.59%) of their patients had normal coronaries, which contrasts markedly with our population where 380 (60.89%) were normal, thus denoting a major difference in populations. They still found significant correlation between a positive T wave in V1 and the presence of CAD, mostly the Cx and to a lesser extent the RCA, but no correlation with the LAD; 9% of their normal patients had positive T wave in V1 [5].

**TABLE I**  
CORRELATION BETWEEN THE POSITIVE T WAVE IN V1 AND THE PRESENCE OF CORONARY ARTERY DISEASE

	CORONARY ARTERY DISEASE		
	Present	Absent	Total
Positive T wave	137	17	154
Negative T wave	107	363	470
<b>Total</b>	<b>244</b>	<b>380</b>	<b>624</b>

OR: 27.34 Se: 56.14% Sp: 95.52% 95% CI: {15.80 - 47.30} PPV: 88.96% NPV: 77.23% p < 0.0001

**TABLE II**  
CORRELATION BETWEEN THE POSITIVE T WAVE IN V1 AND SIGNIFICANT STENOSIS OF THE CIRCUMFLEX CORONARY ARTERY

	STENOSIS OF THE CIRCUMFLEX CORONARY ARTERY		
	Significant	Non Significant	Total
Positive T wave	128	26	154
Negative T wave	14	456	470
<b>Total</b>	<b>142</b>	<b>482</b>	<b>624</b>

OR: 160.35 Se: 90.14% Sp: 94.60% 95% CI: {81.34 - 316.09} PPV: 83.12% NPV: 97.02% p < 0.00001

**TABLE III**  
CORRELATION BETWEEN THE POSITIVE T WAVE IN V1 AND PRESENCE OF CORONARY ARTERY DISEASE IN NON DIABETICS

	CORONARY ARTERY DISEASE		
	Present	Absent	Total
Positive T wave	94	11	105
Negative T wave	80	329	409
<b>Total</b>	<b>174</b>	<b>340</b>	<b>514</b>

OR: 35.14 Se: 54.02% Sp: 96.7% 95% CI: {17.9 - 68.7} PPV: 89.52% NPV: 80.44% p < 0.0001

**TABLE IV**  
CORRELATION BETWEEN THE POSITIVE T WAVE IN V1 AND SIGNIFICANT STENOSIS OF THE CIRCUMFLEX CORONARY ARTERY IN NON DIABETICS

	STENOSIS OF THE CIRCUMFLEX CORONARY ARTERY		
	Significant	Non Significant	Total
Positive T wave	88	17	105
Negative T wave	8	401	409
<b>Total</b>	<b>96</b>	<b>418</b>	<b>514</b>

OR: 259.47 Se: 91.66% Sp: 95.93% 95% CI: {108.5 - 620.2} PPV: 83.8% NPV: 98.04% p < 0.00001

On the other hand, Stankovic *et al.* [6] whose inclusion criteria were closer to ours, studied only 126 patients who had coronarography, only 38.8% of their small sample were normal out of whom 38.7% had upright T wave in V1. They found significantly more upright T wave in V1 in patients with significant CAD, including the Cx and the LAD. Their correlation with LAD is unusual and the high incidence of positive T wave in normals is certainly unexpected. These findings are controversial and

possibly related to the very small sample or possibly the data analysis... Nevertheless, an upright T wave in V1 was significantly more in CAD patients.

As already observed above the differences are mostly related to the different populations and the small number of patients especially in the Stankovic group, whose results are difficult to interpret especially the relation to LAD disease and the large number of upright T waves in V1 in the normal group.

Our study included a much larger number of patients with normal ECG's and coronary angiography correlation. The large number of normals is in agreement with our selection criteria, our population being a group of patients with normal ECGs referred for cath. It is evident that in this population of patients an upright T wave in V1 is a strong indicator of Cx CAD. A second strong point in our study is that this correlation between upright T wave in V1 and CAD and particularly the Cx was maintained in patients without diabetes which on its own is considered a CAD equivalent.

#### LIMITATIONS

Our study is retrospective, and includes patients referred for coronary angiography, so it does not represent the general population, but is certainly the closest, because of the strict inclusion criteria, which is reflected by the large number of normals unlike all previous studies.

#### CONCLUSION

In patients referred for coronary arteriography a positive T wave in V1 is significantly correlated with CAD and in particular the circumflex coronary artery.

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