

Angiocardiographic findings in patients with biphasic T-wave inversion in precordial leads

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Abstract

Objective: To determine the angiocardiographic findings in patients with unstable angina showing biphasic inversion of T-waves in precordial leads on electrocardiogram, commonly referred to as the Wellen's syndrome.

Methods: The descriptive, cross-sectional study was carried out at the National Institute of Cardiovascular Diseases, Karachi, between February and November, 2010. Using convenience sampling, the first 100 consecutive patients showing the characteristic electrocardiogram pattern with a history of chest pain indicative of unstable angina and undergoing coronary angiography were included. Data was collected with the aid of a questionnaire to assess the coronary risk factors, and angiographic findings were recorded during cardiac catheterisation of the patients. All the data collected was sorted and analysed on SPSS version 16 for statistical analysis.

Results: Biphasic T-wave inversion was seen most commonly in leads v2-v3 in 26 (26%) patients, and in leads v2-v4 in 25 (25%) patients. Angiographic findings revealed that 50 (50%) patients had coronary artery stenosis in the proximal part of the left anterior descending artery, while 22 (22%) showed the occlusion in the middle segment. Right coronary artery established the dominance of heart in 75 (75%) of the patients and the two-vessel disease was most commonly observed during cardiac catheterisation.

Conclusion: The classical pattern of biphasic T-wave inversion on electrocardiogram was seen associated with stenosis in the proximal as well as middle part of the left anterior descending coronary artery. This electrocardiogram pattern may not be well defined during the symptomatic phase of acute ischaemia and, hence, maybe overlooked. Prompt recognition and early intervention may significantly reduce morbidity and mortality in such patients.

Keywords: Wellen's syndrome, T-wave inversion, Coronary angiography (JPMA 62: 548; 2012).

Introduction

Case-reports have demonstrated a strong association between biphasic inversions of T-waves in precordial leads on electrocardiogram (ECG) with severe stenosis in the proximal part of the left anterior descending (LAD) coronary artery in patients with ischaemic heart diseases (IHD). Wellen's syndrome is a characteristic pattern of T-wave changes on ECG indicating a high-grade stenosis of proximal LAD in those patients who present with unstable angina, at a time when there is no pain.¹⁻⁴ The T-wave findings in anterior leads can take various forms of appearance, most commonly present in one of the two forms; in approximately 75% of the cases, T-waves are deeply inverted (>2mm) with a symmetrical contour, while in the remaining 25%, T-waves are biphasic.^{4,5} During episodes of angina, the inverted or biphasic T-waves normalise with either ST-elevation or depression, the time when the coronary vessel is significantly narrowed or occluded.¹ The diagnostic leads for T-wave changes in this syndrome are v2 and v3, indicating the typical occlusion between the first and second

septal branches of LAD, although this narrowing can be more proximal with more widespread changes in the T-wave on ECG.⁵ Cardiac biomarkers are not helpful in diagnosis as they are usually within the normal range, or mildly elevated, except in 12% patients and even in them, the values are usually less than twice the upper limit of normal.⁶ Syndrome criteria also include history of angina, lack of pathological Q waves and normal precordial R-wave progression. In 1982, Wellens et al. demonstrated in their study that 75% of patients with typical syndrome manifestations who were not revascularised developed an extensive anterior wall myocardial infarction (MI) within a few weeks after admission, even when on medical treatment,¹ thus signifying the dominance of percutaneous coronary intervention (PCI) over medical therapy alone. Stress test is contraindicated in these patients as there is minimal collateral circulation to compensate for a large part of the anterior myocardium, thus precipitating an acute MI due to increased cardiac demand. This makes urgent coronary angiography with subsequent PCI or coronary artery bypass

graft (CABG) essential for patients who show this ECG pattern.³ The aim of the current study was to observe the significance of these subtle, easily-ignored electrocardiographic findings with LAD stenosis in our population.

Patient and Methods

The descriptive, cross-sectional study was carried out in the catheterisation laboratory of the National Institute of Cardiovascular Diseases (NICVD), Karachi. Using convenience sampling, the first 100 cases admitted between February and November, 2010, with a history of chest pain indicative of unstable angina and with ECG features of typical biphasic T-wave inversion in precordial leads were included. These patients were scheduled for the procedure of coronary angiography.

After approval by the ethical committee of NICVD, consent was taken from all the male and female participants. However, patients with valvular heart diseases, ventricular hypertrophy, congenital heart diseases, atrial fibrillation, atrial flutter, heart block, pre-excitation syndrome and bundle branch block were excluded. Furthermore, patients with history of uncontrolled hypertension, decompensated congestive heart failure, refractory arrhythmia, cerebro-vascular accidents (CVA), coagulopathy, gastrointestinal (GI) haemorrhage, renal failure, pregnancy, active infection, contrast medium allergy or those showing refusal to give informed consent were also excluded from the study.

With the aid of a precise questionnaire, many significant variables, including age, were extracted, which were linked to the patients' number of blocked arteries and the ECG findings. In addition, the questionnaire was designed to gather information pertaining to the patients' risk factors.

All patients were individually contacted, interviewed and appropriate questions were asked. Detailed clinical history and examination were also carried out. Electrocardiogram, fasting and post-prandial blood sugar, fasting lipid profile, and Prothrombin Time/International Normalised Ratio (PT/INR) were performed in every patient followed by cardiac catheterisation.

The study did not involve any follow-up on the subjects. The data from each individual was collected only during their initial cardiac catheterisation.

The procedure of coronary angiography was performed using either the radial or the femoral artery. Dominance of the heart was determined as right, left or co-dominance. Besides, 70% stenosis of the arterial luminal diameter (in any view) was considered a significant lesion. As the objective of this study was to determine LAD stenosis in relation to T-wave inversion, lesions of LAD recorded as proximal, mid, distal, ostial, proximal-distal, left main stenosis were accounted for as

separate variables. On the basis of lesions, diagnosis of SVD, 2VD and 3VD was made. Left main coronary lesions were counted when the luminal diameter was reduced by 50%.

The data collected was analysed on SPSS version 16. Age was presented as mean \pm standard deviations (SD). Categorical variables like dominance, LAD stenosis and diagnosis were worked out in frequencies and percentages, and chi-square test was used to evaluate significant association between the most common biphasic T-wave groups and categorical variables. P-value less than 0.05 was considered statistically significant.

Results

Out of the total of 100 patients included in the study, 26 (26%) patients showed biphasic T-wave inversion in leads v2-v3 (Group 1), whereas 25 (25%) patients showed these changes in leads v2-v4 (Group 2) (Figure). The mean age of the subjects was 53.5 ± 9.2 years. The mean age of the patients in Group 1 was 55.92 ± 8.88 years, higher than patients in Group 2 who had mean age of 49.92 ± 8.03 years, with p-value of independent t-test significant ($p < 0.05$).

Right coronary artery established the dominance of the heart in 75 (75%) patients. It was further seen that 14 (14%) patients showed co-dominance and the remaining had left-sided dominance.

The most common site of lesion was proximal LAD, seen in 50 (50%) patients. However, in 22 (22%) patients, coronary lesion was found in the middle segment of LAD artery followed by ostial (9%), proximal-distal (8%) and diagonal (7%). In Group 1, proximal LAD stenosis was present

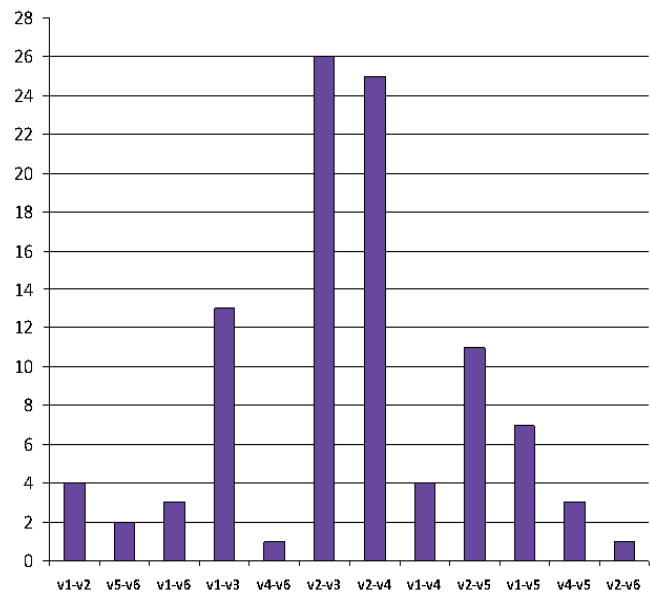


Figure: Distribution of T-wave inversion findings in different precordial chest leads.

Table: Electrocardiographic characteristics of patients and angiographic findings in the most common chest precordial leads.

Variables	Total (n =100)	Biphasic T wave Inversion from v2-v3 (n = 26)		Biphasic T wave Inversion from v2-v4 (n = 25)	
			P-value		P-value
Dominance					
RCA	75	17 (65.4%)	NS	21 (84%)	NS
Co-dominance	14	3 (11.5%)	NA	2 (8%)	NA
Left	11	6 (23.1%)	<0.05*	2 (8%)	NA
LAD					
Proximal	50	8 (30.77%)	<0.05*	15 (60%)	NS
Mid	22	6 (23.07%)	NS	2 (8%)	NS
Osteal	9	3 (11.5%)	NA	4 (16%)	NA
Proximal + Distal	8	2 (7.7%)	NA	15 (60%)	NA
Not LAD/Diagonal	7	8 (30.77%)	<0.05*	4 (16%)	NS
Distal	2	2 (7.7%)	NA		NA
Diagnosis	29	5 (19.23%)	NS	8 (32%)	NS
Single Vessel	41	7 (26.9%)	NS	11 (44%)	NS
Double Vessel	28	12 (46.15 %)	<0.05*	6 (24%)	NS
Triple Vessel	2	2 (7.7%)	NA	0	NA
Left Main					

Note: *Statistically Significant; NS: Not significant; NA: Non-applicable.

in 8 (30.8%) out of 26 patients, while in Group 2, it was present in 15 (60%) out of 25 patients.

It was further seen that the two-vessel coronary disease (2VD) was present in 41% of the patients. In Group 1, 2VD was present in 7 (26.9%) out of 26 patients, and in Group 2, it was noted in 11 (44%) out of 25. Single-vessel disease was found in 29 (29%) patients; 5 (19.23%) in Group 1, and 8 (32%) in Group 2. Three-vessel disease (3VD) was noted in 28 patients; 12 (46.1%) in Group 1 and 6 (24%) in Group 2. The left main artery disease was seen in only 2 (2%) patients, both from Group 1.

Discussion

Characteristic biphasic T-wave changes in precordial leads without Q-waves in a pain-free period is called Wellens' syndrome and is associated with severe proximal LAD stenosis. Hence, it is also termed LAD coronary T-wave syndrome.⁵ In patients admitted with unstable angina, this characteristic ECG pattern is not a rare finding, present in 14-18% of the cases.^{1,6} The term was coined for the first time by Tilkian,⁷ representing a pre-infarction stage of coronary artery disease (CAD).⁸ Since the LAD supplies the anterior myocardium, patients with this T-wave pattern on ECG are at a high risk of development of extensive infarction of the anterior wall, with a mean time of approximately 8.5 days from the onset of Wellen's syndrome to infarction.¹ These patients require immediate coronary angiography, revascularisation strategies and aggressive medical management.³ Studies have shown gradual disappearance of characteristic T-wave findings in the ECG after revascularisation, hence indicating successful PCI.¹

As seen in our study, biphasic T-waves of Wellen's

syndrome are most commonly observed in leads v2-v3. Similar studies have affirmed leads v2 and v3 to be the diagnostic leads for biphasic T-waves, leads v4-v6 being less common.^{6,9} A study has highlighted that biphasic T-waves may represent critical stenosis in the artery related to the leads in which these specific changes are seen.¹⁰

The T-wave changes may persistently remain for hours or weeks.⁹ The presence of these characteristic T-wave changes in patients with unstable angina is predictive of significant coronary artery stenosis, and identifies a sub-group with poor prognosis when on medical therapy.¹¹ Coronary angiographic findings demonstrated that the most common site for coronary vessel occlusion was proximal LAD. A study showed that in 83% of the cases, LAD occlusion site was found proximal to the second septal perforator.¹² This finding has also been seen in various other studies.¹³ However, in 22% of our patients, coronary lesion was found in the middle part of the LAD. Similar findings have been stated in a few case reports, where occlusion was seen in the middle of the LAD rather than the proximal part.⁹ Our study also showed significant lesions in diagonal branch in 8 (30.77%) patients who showed biphasic T-wave inversion in leads v2-v3 ($p \leq 0.05$).

It is interesting to note that these characteristic ECG findings of Wellen's criteria can also be seen in cases of pulmonary embolism, central nervous system injury or due to drug-induced effects.¹²

Conclusion

Characteristic findings in precordial leads should not be overlooked even if there is no ST-deviation. Since this artery supplies the anterior myocardium, inability to recognise this

specific ECG pattern can result in massive infarction of the anterior wall, substantial left ventricular dysfunction, and/or death. Most significantly, the classic ECG presentation of Wellens' syndrome may be imprecise during the acute phase of ischaemia, and appear after chest pain has subsided when everybody proceeds at a slow and relaxed pace. Early intervention and revascularisation strategies are recommended for patients with such ECG findings.

References

1. de Zwaan C, Bar FW, Wellens HJ. Characteristic electrocardiographic pattern indicating a critical stenosis high in left anterior descending coronary artery in patients admitted because of impending myocardial infarction. *Am Heart J* 1982; 103: 730-6.
2. Tandy TK, Bottomy DP, Lewis JG. Wellens' syndrome. *Ann Emerg Med* 1999; 33: 347-51.
3. Goor Y, Magal R, Goor O, Frimerman A, Cabili S. Critical myocardial ischaemia: minor electrocardiographic changes - Wellens' Syndrome. *Isr Med Assoc J* 2003; 5: 129-30.
4. Sobnosky S, Kohli R, Bleibel S. Wellens' Syndrome. *Int J Cardiol* 2006; 3: 1.
5. Nisbet BC, Zlupko G. Repeat Wellens' syndrome: case report of critical proximal left anterior descending artery restenosis. *J Emerg Med* 2010; 39: 305-8.
6. de Zwaan C, Bar FW, Janssen JH, Cheriex EC, Dassen WR, Brugada P, et al. Angiographic and clinical characteristics of patients with unstable angina showing an ECG pattern indicating critical narrowing of the proximal LAD coronary artery. *Am Heart J* 1989; 117: 657-65.
7. Conover MB. *Understanding Electrocardiography*. St. Louis: Mosby - Year Book, Inc: 1996; 344-61.
8. Tatli E, Aktoz M. Wellens' syndrome: the electrocardiographic finding that is seen as unimportant. *Cardiol J* 2009; 16: 73-5.
9. Kardesoglu E, Celik T, Cebeci BS, Cingozbay BY, Dincturk M, Demiralp E. Wellens' syndrome: a case report. *J Int Med Res* 2003; 31: 585-90.
10. Vanpee D, Courouble P, Marchandise B, Gillet JB. Wellens' syndrome. *Ann Emerg Med* 1999; 34: 684-5.
11. Haines DE, Raabe DS, Gundel WD, Wackers FJ. Anatomic and prognostic significance of new T-wave inversion in unstable angina. *Am J Cardiol* 1983; 52: 14-8.
12. Rhinehardt J, Brady WJ, Perron AD, Mattu A. Electrocardiographic manifestations of Wellens' syndrome. *Am J Emerg Med* 2002; 20: 638-43.
13. Mead NE, O'Keefe KP. Wellens' syndrome: An ominous EKG pattern. *J Emerg Trauma Shock* 2009; 2: 206-8.