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Characteristics Of Patients with Wellens Syndrome Who Underwent Coronary Angiogram: A Single Center Experience

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ABSTRACT

Introduction: Wellens syndrome refers to a characteristic set of ECG abnormalities associated with simultaneous severe stenosis of the proximal part of the left anterior descending artery (LAD). Early intervention with percutaneous coronary intervention (PCI) is paramount otherwise may result in anterior wall myocardial infarction or even death.
Objectives: The major objective of this study was to determine the clinical, echocardiographic and angiographic features which are specific to Wellens syndrome in order to diagnose the patients and manage them urgently to reduce morbidity and mortality.
Methodology: 52 patients with Wellens syndrome were recruited for a descriptive cross-sectional study conducted in the cardiology unit of the National Hospital of Kandy, Sri Lanka. All the recruited patients underwent serial ECGs, blood for cardiac markers, and a comprehensive 2D echocardiogram within 24 hours of admission. An interviewer-administered questionnaire was used for data collection and all the data was analyzed by statistical package for the social sciences (SPSS) 23 software.
Results: The majority of affected patients were males (71.2%). More than half of the participants had very severe stenosis of LAD (52.1%), one-fifth of them had severe stenosis (22.9%), and about one-third were suffering from triple vessel disease (TVD: 32.69%) according to the angiogram. Characteristically, 83% of diagnosed patients with Wellens syndrome had not complained of any pain during their diagnostic ECG tracing and the majority had normal cardiac troponin levels (82.7%) at the presentation.
Conclusions: Even though the ECG findings of Wellens syndrome are highly specific (89%), due to either normal or slightly elevated levels of cardiac markers and the pain-free status of the patients at the presentation often mislead the physicians. Late diagnosis may result in extensive myocardial damage and even death. Therefore, early identification and intervention is vital.

Keywords: Wellens syndrome, Coronary Angiogram

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INTRODUCTION

Wellens syndrome was first described as a set of characteristic electrocardiographic (ECG) changes associated with a severe lesion in the left anterior descending artery in the early 1980s, by de Zwaan, Wellens, and colleagues. They were identified as a subset of patients with unstable angina who had specific precordial T-wave changes and subsequently developed a large anterior wall myocardial infarction (MI) (1). They had negative or minimally elevated markers of myocardial necrosis, deeply inverted biphasic T waves in V2 and V3 leads due to a severe obstruction in the LAD artery.

Typical presentation of Wellens syndrome is with a history of angina with no or slight increase in cardiac enzymes. When considering the electrocardiographic changes, namely deeply inverted T waves without significant ST elevation and pathological Q waves in anterior leads with a normal R wave progression. Apparently, patients are asymptomatic when the ECG changes are found. Development of ECG changes occurs over hours to weeks.

The characteristic ECG pattern in Wellens syndrome is described as biphasic T waves (Type A) or deeply inverted (Type B) in V2-3 (may extend to V1-6), isoelectric or minimally elevated ST segment (< 1mm,) without having precordial Q waves and preserved precordial R wave progression (2). However, only some symptomatic patients with a critical narrowing of LAD exhibit a typical Wellens pattern, while the majority presents with ST-segment depression or normal resting electrocardiogram (ECG). Following the first identification of the Wellens syndrome in 1980 and a series of case reports, emergency physicians have become increasingly aware of this high-risk subset of patients, but the aetiology of the Wellens T-waves remains undetermined.

Previous studies have revealed that ischemic memory links to post-systolic shortening, i.e., prolongation of myocardial contraction beyond end-systole. This study reported that there is a correlation between myocardial contraction and QTc interval in patients with chest pain and critical LAD stenosis (3). Therefore, there could be a possibility of differences in the anterograde or retrograde epicardial flow through a significantly narrowed LAD lesion leading to the appearance of Wellens ECG pattern.

According to Wellens (4), 18% of patients who were admitted with UA have shown the ECG pattern of Wellens syndrome and 75% of patients who have only received symptomatic treatment, developed extensive anterior myocardial infarction within a few weeks. These findings emphasize the importance of urgent angiography in patients who show the typical ECG pattern of Wellens syndrome. To prevent these patients developing extensive anterior wall infarction, revascularization should be done as soon as possible. Further, it should be stressed that in the patients with Wellens syndrome, stress testing is contraindicated.

METHODOLOGY

Study Design and Setting

Patients with clinical diagnosis of Wellens syndrome at Cardiology Unit, National Hospital Kandy from 01/03/2020 to 01/03/2021 were recruited for a descriptive cross-sectional study. Sequential ECG monitoring and cardiac troponin I evaluation was done in all the patients after 6 hours of chest pain. Treatment for the patients were started according to the management of unstable angina /NSTEMI standard guidelines. All patients underwent coronary angiogram within 24-48 hours of admission for coronary imaging. Following coronary angiogram, patients who had PCI acquiescent lesion were treated with percutaneous coronary intervention and the rest of the patients were managed with either medical management or CABG.

Inclusion Criteria

- Patients with ECG features suggestive of Wellens pattern,
- with or without chest pain
- recent history of angina,
- with normal or slightly elevated serum cardiac markers were included.

Exclusion Criteria

- Patients with the high troponin values
- Patients with previous myocardial infarctions, pathological Q-waves, ongoing arrhythmias, left bundle branch block,
- more than mild valvular heart disease was not recruited for this study.

Data Collection

Demographic and other clinical data were collected through an interviewer administered questionnaire. ECG records were reviewed by 2 of the investigators. Coronary angiography was performed by a senior registrar in cardiology or a cardiologist.

Statistical Analysis

All data were transferred to the Statistical Package for Social Sciences (SPSS) version 23 data sheet. The descriptive statistics were calculated for all variables. For the continuous variables, the mean, median, interquartile ranges, and standard deviations were calculated. Frequencies and percentages were calculated for the categorical variables. The comparisons were done using the chi-square test for categorical variables and the student's t-test for continuous variables. The statistical significance was taken as a p-value less than 0.05. According to the suitability, graphs, charts, and tables were inserted to summarize the findings.

Ethical Clearance

Ethical clearance was obtained from the Ethical Review committee of the National Hospital Kandy. All data was collected following informed written consent. Confidentiality was assured. If any lapse was found during the interview process, regarding knowledge or practices they were corrected after the interview by a short discussion with the patient.

RESULTS

The total sample size was 52 and this chapter describes the significant study results.

Baseline characteristics of the study sample

Table 01: Demographic factors

Factors	Frequency (%)
Age - Years (Mean ± SD)	56.58 ± 9.880
Gender	
Male	71.2% (n=37)
Female	28.8% (n=15)

Table 01 demonstrates the demographic characteristics of the study sample. The mean age of the sample was 56 ± 9.880 years, and the majority of the participants were males (71.2%).

Table 02: Co-morbidities

Comorbidities	Frequency (%)	Duration in years (Mean ± SD)
Diabetes	38.5% (n=20)	2.30 ± 2.96
Hypertension	48.1% (n=25)	4.34 ± 4.05
Dyslipidemia	36.5% (n=19)	3.92 ± 3.98

Table 02 describes the co-morbidities of the sample. The majority of the patients suffered from metabolic disorders, with hypertension (48.1%), diabetes 38.5% (n = 20) and dyslipidemia 36.5% (n = 19) respectively.

Table 03 demonstrates the risk factors for the development of cardiovascular diseases in the study sample. Only 7.7% of the participants had a history of a myocardial infarction. When considering the BMI, the majority were in normal (61.5%, n = 32) category and only 26.9% (n = 14) were overweight and 3.8% were obese. Most of the patients have never smoked (70.6%) and 19.6% were current smokers. The total mean duration of smoking was 19.06 ± 14.694 years with a mean of 7.83±6.973 pack years. The majority of smokers used cigarettes (86.7%, n = 13).

Table 03: Risk factors

Factors	Frequency (%)
History of Myocardial Infarction (MI)	7.7 % (n=4)
BMI Categories	
Underweight (<18.5 kg/m^2)	7.7 % (n=4)
Normal weight (18.5-22.9 kg/m2)	61.5 % (n=32)
Overweight (23-24.9 kg/m2)	26.9% (n=14)
Obesity (>25 kg/m2)	3.8% (n=2)
Smoking	
Never smoked	70.6% (n=36
Former smoker	9.8% (n=5)
Current smoker	19.6% (n=10)
Duration of smoking in Years (Mean ± SD)	19.06 ± 14.69
Smoking type	
Cigarettes	86.7 % (n=13)
Beedi	6.7% (n=1)
Cigarettes + Beedi	6.7% (n=1)
Number per day (Mean ± SD)	7.40 ±5.180
Pack years (Mean ± SD)	7.83±6.973

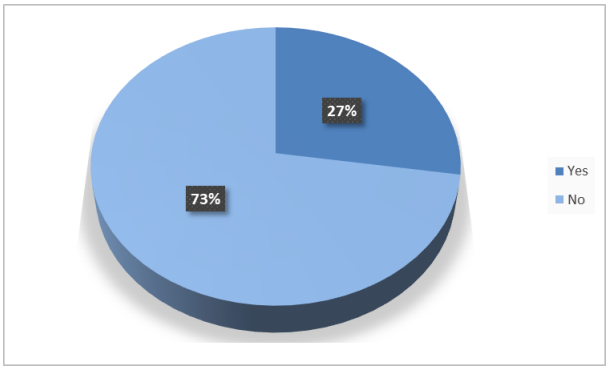

Figure 01: Family history of Myocardial Infarction (MI)

Of the sample, only 27% of participants had a family history of myocardial infarction. (figure 01).

Table 04: Details of family history of myocardial infarction

Relationship	Frequency (%)
Relation	
Father	42.9% (n=6)
Mother	42.9% (n=6)
Brother	14.3% (n=2)
Outcome	
Living	16.7% (n=1)
Death	83.3% (n=5)

Out of those who had a positive family history, a similar proportion of participants have either a father (n = 6, 42.9%) or a mother (n = 6, 42.9%). The majority of affected family members had died at the time we collected our data.

Investigations

Table 05: Investigations

Variable	Frequency (%)
Troponin	
Positive	17.3% (n=9)
Negative	82.7% (n=43)
EF (Mean ± SD)	50.19 ± 7.205

This table demonstrates the results of the specific investigation of the participants. Out of all participants, only 17.3% (n = 9) had positive results for the Troponin test. The mean ejection fraction of the Echocardiogram done within 24 hours of admission was 50.19 ± 7.205 %.

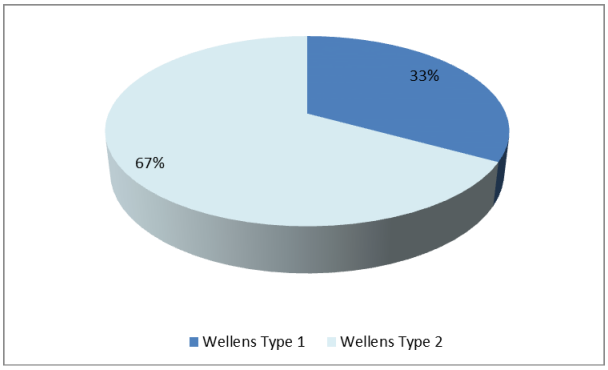

Figure 02: Distribution of the type of ECG

This figure depicts the distribution of the type of ECG of the study participants. The majority had the Wellens type B ECG pattern (n = 35, 67%), and the rest of the participants had the Wellens type A pattern (n = 17, 33%).

Angiographic Characteristics

Table 06: Distribution of Angiogram results

Variable	Frequency (%)
Minor coronary arterial diseases	7.69% (n=4)
Normal	3.84% (n=2)
Single vessel disease (SVD)	36.54% (n=19)
Double vessel disease (DVD)	19.23% (n=10)
Triple vessel disease (TVD)	32.69% (n=17)

When considering the results of coronary angiogram, 36.54% of participants had SVD. 32.69% and 19.23% had TVD and DVD respectively.

Table 07: Evaluation of the status of the proximal part of the left anterior descending artery

The severity of the stenosis	Frequency (%)
Normal (<60%)	14.6% (n=7)
Moderate (60-70%)	10.4% (n=5)
Severe (>70%)	22.9% (n=11)
Very severe >90%)	52.1% (n=25)

LAD Prox - Proximal part of the Left Anterior Descending artery

Table 07 demonstrates the status of the proximal part of the left anterior descending artery. The majority of participants had very severe stenosis (n = 25, 52.1%), 22.9% had severe stenosis (n = 11), and only 10.4% had moderate stenosis of the proximal part of the left anterior descending artery.

When considering the dominant arterial supply of the heart, the majority had shown an RCA predominance (78.0%) and only 12.2% (n = 6) had LCX dominance.

Table 08: Dominance of the arteries

Dominance	Frequency (%)
Co-dominant	4.9% (n=2)
Left Circumflex artery (LCX)	12.2% (n=6)
Right Coronary Artery (RCA)	78% (n=33)

Table 10 demonstrates the association between stenosis of the proximal part of the left anterior descending artery, demographic factors and co-morbidities. Out of the patients who had very severe stenosis of the proximal part of the LAD artery, the majority belonged to the age group of 40 - 60 years (60.0%), were male (80.0%), and were suffering from hypertension (48.0%) and diabetes (40.0%). Similarly, in the group of severe stenosis, most of the patients were males (90.9%) and were suffering from several co-morbidities.

Table 09: Association between stenosis of the proximal part of the Left Anterior Descending artery and demographic factors and co-morbidities.

Variable	LAD prox			
	Normal (N=7)	Moderate (N=5)	Severe (N=11)	Very severe (N=25)
Age				
40-60 years	100% (n=7)	80% (n=4)	72.7% (n=8)	60% (n=15)
> 60 years	0% (n=0)	20% (n=1)	27.3% (n=3)	40% (n=10)
Gender				
Male	14.3% (n=1)	80% (n=4)	90.9% (n=10)	80% (n=20)
Female	85.7% (n=6)	20% (n=1)	9.1% (n=1)	20% (n=5)
Comorbidities				
Diabetes	72.9% (n=3)	20% (n=1)	36.4% (n=4)	40% (n=10)
Hypertension	71.4% (n=5)	60% (n=3)	45.5% (n=5)	48% (n=12)
Dyslipidemia	57.1% (n=4)	20% (n=1)	45.5% (n=5)	36.0% (n=9)
History of MI	28.6% (n=2)	0% (n=0)	9.1% (n=1)	4.0% (n=1)

Distribution of Pain during the ECG recording

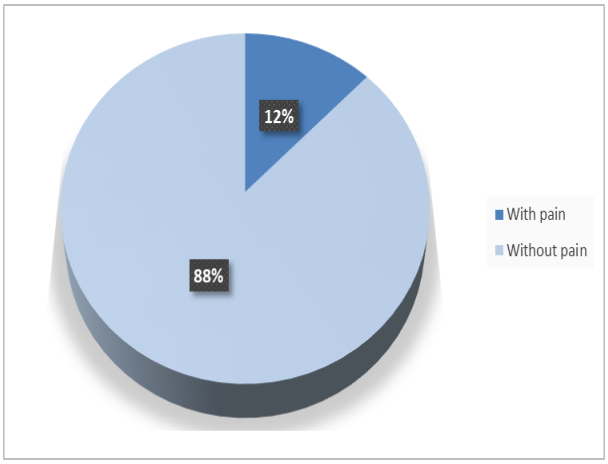

Figure 03: Distribution of Pain during the ECG recording

According to this pie chart, the majority (88%) had not complained of any pain during the ECG recording and only 12% had pain.

This table demonstrates the association between ECG recording and demographic factors and comorbidities. There was no statistically significant association between the presence of pain during ECG recording and the demographic and risk factors.

Table 10: Association between ECG recording and demographic factors and co-morbidities.

Variable	Pain during the ECG recording		P Value
	With pain	Without pain	
Age			
40-60 years	83.35 (n=5)	66.7% (n=28)	0.650*
> 60 years	16.7% (n=1)	33.3% (n=14)	0.660*
Gender			
Male	66.7% (n=4)	73.8% (n=31)	0.656*
Female	33.3% (n=2)	26.2% (n=11)	0.664*
Comorbidities			
Diabetes	16.7% (n=1)	42.9% (n=18)	0.381*
Hypertension	33.3% (n=2)	50.0% (n=21)	0.668*
Dyslipidemia	16.7% (n=1)	40.5% (n=17)	0.388*
History of MI	16.7% (n=1)	4.8% (n=2)	0.336*

*Fisher's exact value

DISCUSSION

Wellens syndrome is comprised of characteristic ECG changes with extensive stenosis of the left anterior descending artery and is often missed as at presentation as there is no associated pain (4, 5). We tried to elaborate on the clinical, echocardiographic, and coronary angiographic features of the patients with Wellens syndrome which may be beneficial in the improvement of current diagnostic and treatment strategies, policy-making, and future research purposes.

When considering the basic characteristics of the study population, the mean age was 56.58 ± 9.880 years, and a significantly higher prevalence was

noted among males (71.2%, n = 37). Moreover, most of the patients with very severe stenosis were males (80.0%, n = 20), and those with severe stenosis were also males (90.9%, n = 10).

The causative factors for the development of Wellens syndrome are similar to any other cardiac disease, mainly diabetes mellitus, hypertension, hyperlipidemia, smoking, and a family history of heart disease (6). Here, the majority were on treatment for hypertension (48.1%, n = 25) and 38.5% and 36.5% were on treatment for diabetes and dyslipidemia respectively. However, the majority were non-smokers (70.6%, n = 36) and the majority had no family history of MI (73%). These factors may have been affected by factors such as cultural background and selection bias of our study sample, so we need further evaluation.

Wellens syndrome is defined by a characteristic pattern of ECG changes without or minimal elevation of cardiac biomarkers and usually, patients present without pain (6). There are two major subtypes of ECG changes described in Wellens syndrome.

- Wellens type A - T waves are biphasic and usually identified in about 25% of the patients.
- Wellens type B - deeply inverted T waves with an approximate prevalence of 75% (6).

In our study, 33% of patients were Wellens type-A while the majority was Wellens Type-B (67%).

The majority (n = 43, 82.7%) of diagnosed patients with Wellens had normal levels of troponin and only 17.3% had elevated levels of cardiac troponin. One prospective study has noted similar results as ours, with only 12% of diagnosed patients with Wellens having elevated levels of cardiac biomarkers (6). These low levels of cardiac biomarkers are falsely assuring the patients, so proper examination of the ECG is the key to correct diagnosis (6).

When considering the symptom profile of these patients they usually experience symptoms similar to acute coronary syndrome, with typical chest pain which may be exaggerated by activities, relieved by rest, and may radiate to the neck and the jaw (6). However, when the patients present to the emergency department, they were usually pain-free, which is one of the diagnostic criteria for Wellens syndrome (6). Similarly, among those who had been diagnosed with Wellens syndrome, the majority (88%) had no pain at the time of recording the ECG which was compatible with the literature. Although they are pain-free until a definitive diagnosis is made, stress testing should be avoided (6). In the index study, even though we could not explore any significant association between the presence of pain during the ECG recording and demographic factors and the comorbidities, the majority of participants without pain belonged to the age group 40 – 60 years and were male (73.8%).

These highly specific ECG changes occur due to the stenosis of the left anterior descending artery (LAD), especially in the proximal part (6). In the present study we noted similar results, where out of 52 participants, 25 (52.1%) had very severe stenosis of the proximal part of the LAD, 11 (22.9%) had severe stenosis, 5 (10.4%) had moderate stenosis while rest of them (n = 7, 14.6%) had normal LAD according to the angiogram. Therefore, it is important to identify the ECG pattern and initiate early definitive treatment with percutaneous coronary intervention (PCI), as otherwise, around 75% of these patients may end up with acute anterior wall myocardial infarctions within weeks of the diagnosis (6,10).

The characteristic changes of ECG pattern in Wellens syndrome are highly specific for the severe stenosis of the proximal part of the LAD artery with sensitivity of 69% and specificity of 89% (6,10). This simultaneous and significant presence of occlusion of other coronary arteries implies a risk of being affected by an acute myocardial infarction in any wall of the heart of these patients.

Even though the ECG changes are characteristic of Wellens syndrome, for the definitive diagnosis, a coronary angiogram is a must (8). Here, the majority (36.546%, n = 19) had been identified as having small vessel disease (SVD) and about 32.69% (n = 17) had triple vessel disease (TVD) according to the angiogram results. This stresses the importance of coronary angiograms in the early identification of cardiac abnormality and the prevention of further myocardial damage.

Limitations

There were several limitations in our study. Firstly, our sample size was only 52 patients, which is relatively small. Hence, the study population only reflects only a small portion of the population and there may be some disparities when generalizing these results. Moreover, the generalization of these study results may need further modifications of this study. Due to the small sample size, we could not demonstrate certain significant associations such as the levels of cardiac markers and severity of stenosis of the LAD.

CONCLUSIONS

In conclusion, the most of affected patients were males (71.2%) who presented with severe stenosis of the proximal part of the LAD artery with either normal or slightly elevated cardiac markers in keeping with Wellens criteria. Over half of the participants had very severe stenosis of LAD (52.1%), one-fifth of them had severe stenosis (22.9%), and about one-third of them were suffering from triple vessel disease (TVD: 32.69%). Characteristically, 83% of diagnosed patients with Wellens syndrome had not complained of any pain during their diagnostic ECG tracing.

Recommendations

Even though the ECG findings of Wellens syndrome are highly specific (89%), due to either normal or slightly elevated levels of cardiac markers and the pain-free status of the patients at the presentation often mislead the physicians. Late diagnosis may result in extensive myocardial damage and even death. Hence, early identification and intervention are paramount. As gender is a significant factor with regard to the development of severe stenosis of the LAD artery, male patients who fit into this typical clinical presentation should be evaluated extensively. It is recommended to perform a coronary angiogram for the definitive diagnosis and cardiac catheterization as the definitive treatment. Further research is deemed essential regarding the characteristics of Wellens syndrome in the Sri Lankan context.

Author declaration

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Authors' contributions:
Study concept and design: S.K.G.P.H.K.S., G.M. and M.J.M.N.; Acquisition of data, analysis, and interpretation of data: M.J.M.N.; Drafting of the manuscript: M.J.M.N., Study supervision: S.R.J., A.K.

Conflicts of interest:
The authors declare that there is no financial or non-financial conflict of interest.

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Ethics statement:
Ethical clearance was received from the ethical review committee of the National Hospital Kandy. Informed consent was obtained from the patients after giving adequate details about the study. Before obtaining the consent, the patients were provided the details regarding the study in the form of an information sheet.

Statement on data availability:
The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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