Differentiating between Exercise-Induced ST-Segment Abnormalities Secondary to Wolff–Parkinson–White (WPW) Syndrome and Acute Myocardial Infarction

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SOUHRN

Kontext: Zátěžové vyšetření (exercise stress testing, EST) může u jedinců s Wolffovým–Parkinsonovým–Whiteovým (WPW) syndromem vést ke stanovení falešně pozitivní diagnózy infarktu myokardu (IM).
Kazuistika: Třicetiletý pacient měl v anamnéze dva měsíce před vyšetřením palpitace a presynkopální stav. Skóre pravděpodobnosti před vyšetřením (pre-test probability, PTP) bylo 1 % a vstupní EKG záznam vykazoval typické znaky WPW syndromu. Dodatečně byla provedena stratifikace rizika formou EST s použitím Bruceova protokolu. V prekordiálních svodech byla při 4. stupni zátěže zaznamenána perzistentní komorová preexcitace (ventricular preexcitation, VPE) s ascendentní 3mm depresí úseku ST, přičemž svod aVR vykazoval 3mm elevaci úseku ST.
Závěr: Pro odlišení IM od abnormální repolarizace u jedinců s WPW syndromem je naprosto zásadní znalost primárních abnormalit ST-T. Pro zjištění příčiny změn vlny ST-T je nezbytná nejdříve „identifikace" pacienta na základě klinických charakteristik a skórování rizika podle PTP. U pacientů s nízkým rizikem a se zátěží vyvolanými změnami úseku ST v kontextu WPW syndromu je nutno uvažovat o falešně pozitivním výsledku vyšetření. Pro odlišení změn během EST v přítomnosti preexcitace je zapotřebí použít holistický přístup, při němž se berou v úvahu výsledky klinického vyšetření, skórování rizika PTP a znalost EKG charakteristik pacienta.

Keywords:
Exercise stress test
Preexcitation syndrome
Wolff–Parkinson–White syndrome

ABSTRACT

Background: Exercise stress testing (EST) can cause false-positive diagnoses of myocardial infarction (MI) in individuals with Wolff–Parkinson–White (WPW) syndrome.
Case: A 30-year-old male had a history of palpitation and near syncope 2 months before examination. The pre-test probability (PTP) score was 1% and baseline ECG showed typical features of WPW syndrome. Additionally, risk stratification was performed with EST using the Bruce protocol. Persistent ventricular preexcitation (VPE) with upsloping 3.0 mm ST-segment depression was found in precordial leads at the fourth stage, while the aVR lead showed a 3.0 mm ST-segment elevation.
Conclusion: Understanding the primary ST-T abnormalities was essential to differentiate MI from abnormal repolarization in individuals with WPW syndrome. Initial identification based on clinical characteristics and PTP risk scoring is crucial for distinguishing the cause of ST-T wave changes. Low-risk patients with exercise-induced ST changes in the context of WPW syndrome should be considered to have received a false-positive exercise test result. A holistic method by clinical investigation, PTP risk scoring, and the identification of ECG characteristics are needed to distinguish the changes during EST in the presence of preexcitation.

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Background

The interpretation of exercise stress testing (EST) in patients with Wolff–Parkinson–White (WPW) syndrome and preexcitation is often challenging and shows false-positive results in the diagnosis of myocardial infarction (MI). The abnormal activation sequence through electrocardiography (ECG) may mimic the characteristic features of MI.[1] ST-elevation in aVR during narrow QRS complex tachycardia suggests atrioventricular reentry through an accessory pathway (AP).[2] Conversely, this phenomenon during EST increases the likelihood of having left main (LM) or ostial left anterior descending (LAD) stenosis.[3] This study presented a case of WPW syndrome with ECG changes mimicking acute MI during EST. The initial identification based on clinical characteristics and pre-test probability (PTP) scoring is crucial for distinguishing ST-T wave changes during EST.

Case presentation

A 30-year-old male visited the outward patient clinic with a history of palpitation and near syncope about two months before the examination. There were no complaints of chest pain, dyspnea, or history of smoking. Upon examination, the patient was conscious, with a regular resting heart rate of 100 bpm and blood pressure of 120/80 mmHg. There were no abnormalities found in the cardiovascular system examination. Other system examinations were normal and the PTP score showed only a 1% likelihood of having obstructive coronary artery disease (CAD).

Chest X-rays, the whole blood count, and biochemical markers were normal, while echocardiography showed normal cardiac function and anatomy. ECG at baseline (Fig. 1) showed a sinus rhythm with a short PR interval and delta waves at the QRS complex, a typical feature in

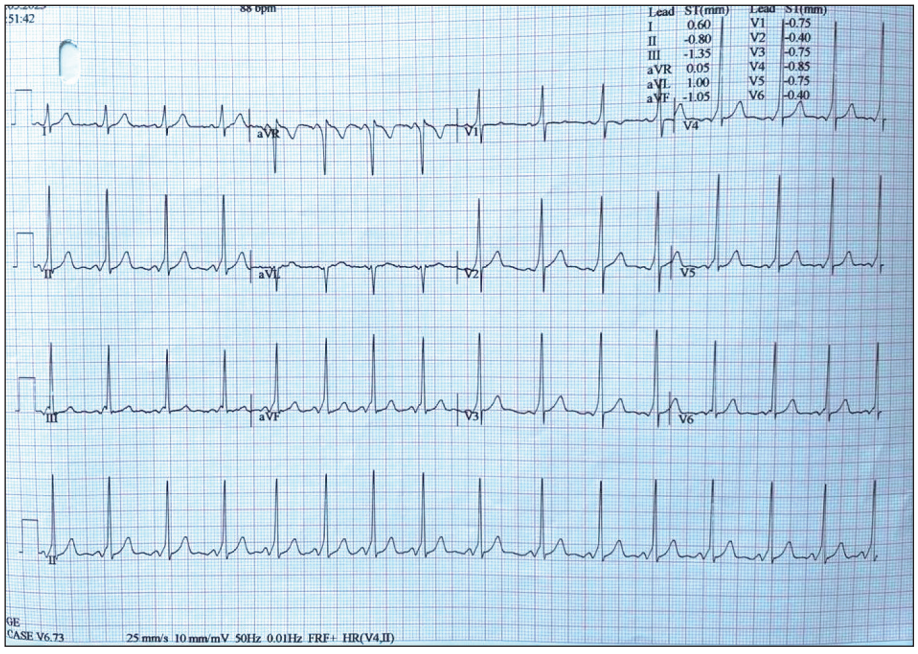

Fig. 1 – ECG baseline showed a sinus rhythm with a short PR interval and delta waves at QRS complex, a typical ECG results in WPW syndrome.

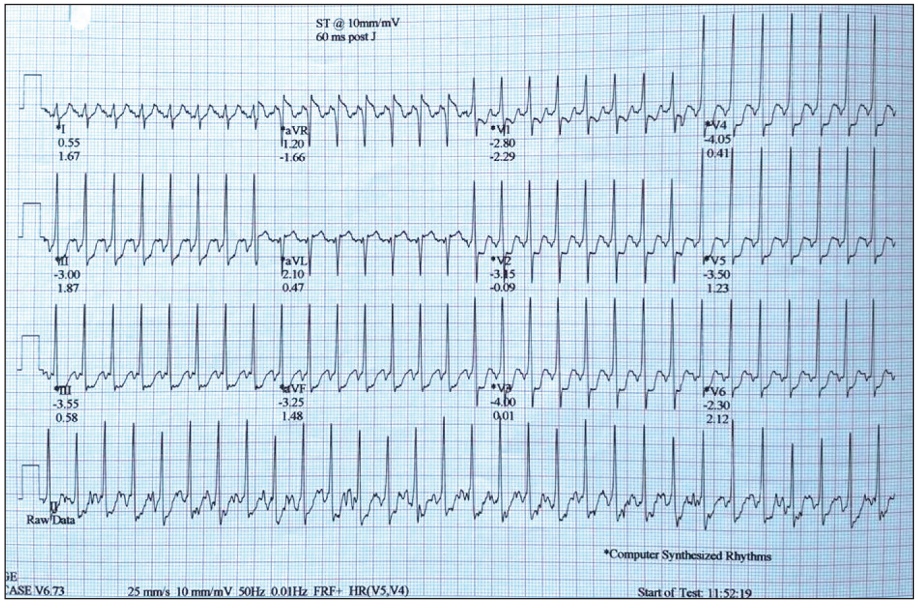

Fig. 2 – ECG during EST showed persistent VPE with upsloping 3.0 mm ST-segment depression in precordial leads; the aVR lead showed a 3.0 mm ST-segment elevation.

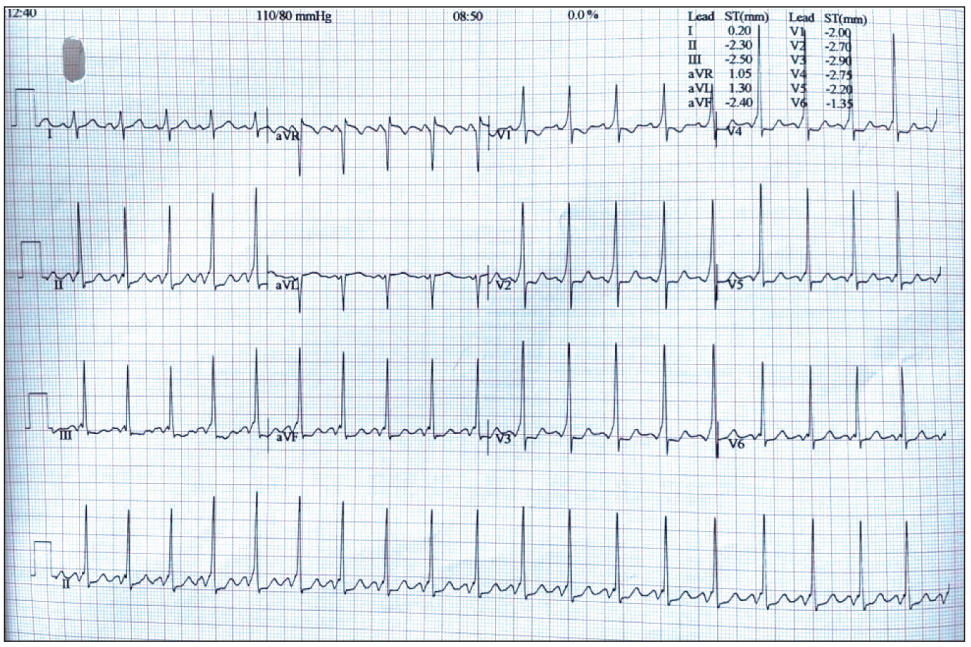

Fig. 3 – ECG at recovery stage. The ECG showed a reduction of ST-segment elevation at the aVR lead and ST-segment depression at the precordial leads; VPE was still persistent.

WPW syndrome. The patient was examined to stratify the risk of WPW syndrome with exercise stress test (EST) using the Bruce protocol. ECG during EST showed persistent ventricular preexcitation (VPE) with an upsloping 3.0 mm ST-segment depression appearing in precordial leads at the fourth stage of the test, while the aVR lead showed a 3.0 mm ST-segment elevation (Fig. 2). EST terminated in the fourth stage since the patient complained of dizziness. During the recovery stage, ECG showed a reduction in ST-segment elevation at the aVR lead and depression at the precordial leads, while VPE was still persistent (Fig. 3).

To exclude the probability of ischemic cause, CT-angiography was performed. The epicardial coronary arteries were normal as shown in Figure 4. Due to the persistent presence of VPE during exercise, it was concluded that the patient had a high risk of WPW syndrome. Consequently, a referral was made to the electrophysiology (EP) division for further invasive investigation, including EP study and/or catheter ablation.

Discussion

ECG pattern of WPW syndrome occurs due to the presence of an AP, known as the bundle of Kent, which bypasses the connection between the atrial and ventricular myocardium. In the absence of a documented tachyarrhythmia or related symptoms, the ECG features alone are referred to as the pattern of WPW syndrome. These features are (i) shortened PR interval (<120 ms) resulting from bypassing the AV nodal delay, (ii) slurred QRS upstroke (delta wave) due to VPE, (iii) prolonged QRS duration (>120 ms), caused by the sum of normal ventricular activation and preexcitation through the AP, and (iv) secondary repolarization changes appearing as ST segment-T wave discordant to major delta waves.[4]

EST can stratify the risk of sudden cardiac arrest/death in patients with WPW syndrome. The persistence of VPE during EST has a sensitivity of 96%, specificity of 17%, as well as a positive and negative predictive value of 40% and 88% in predicting the AP effective refractory period (APERP) of ≤250 ms. This shows a high risk of WPW syndrome, thereby warranting further invasive investigation.[4,5] ST-segment depression in the presence of delta waves during EST is generally false positive for ischemia. In patients with WPW syndrome, ischemic and injury-induced ST-T waves can be masked and/or mimicked by secondary ones due to aberrant depolarization and repolarization through AP. The depression generally normal-

Fig. 4 – CT angiography shows normal coronary arteries.

izes after a loss of the delta wave and with the return of normal ventricular repolarization through AV-node conduction. When a loss of the delta wave occurs close to peak exercise, accompanied by complete resolution of ST-segment depression, further examination is unnecessary as this confirms false positive results.[6]

The ECG manifestation of secondary ST-T wave changes due to WPW syndrome can be identified by several key features. These include ST-T wave deviating in the opposite direction to the delta wave vector, a positive correlation between the degree of preexcitation and ST-T wave changes, as well as a nonhorizontal, nonsymmetrical T-wave inversion. Previous studies reported that manifest preexcitation caused 1.0–4.0 mm of ST depression.[7,8] In this study, EST showed ST-segment depression in precordial leads and elevation at aVR, potentially mimicking acute MI. However, the ECG showed likely features of secondary wave changes, and the diagnosis was confirmed by clinical characteristics, PTP scoring, and CT angiography with normal coronary results. ST-segment elevation in aVR during narrow QRS complex tachycardia suggested AVRT as the possible mechanism. The observed changes were presumably due to distortion caused by the retrogradely conducted P-wave.[2]

Understanding the primary ST-T abnormalities is essential for differentiating acute MI from abnormal repolarization in WPW syndrome. ECG features of primary ST-T wave changes are as follows: concordant or discordant with the delta wave vector, horizontal depression, symmetrical T-wave inversion, and ST-T changes in 2 or more contiguous leads in the presence of clinical ischemic symptoms.[1] Initial identification based on clinical characteristics and PTP risk scoring is crucial for distinguishing the cause of these wave changes. A PTP risk score <15% shows a low likelihood of CAD and further investigation is either unnecessary or deffered.[9] In this study, the patient had no clinical symptoms related to typical angina with no associated risk factors. Therefore, low-risk patients with exercise-induced ST changes in the context of WPW syndrome should be considered to have received a false-positive exercise test result.

Conclusion

In conclusion, this case report showed that a high index of clinical suspicion must be maintained when interpreting ECGs in the preexcitation phase to avoid overlooking the associated CAD. A holistic method comprising clinical investigation, PTP risk scoring, and the identification of ECG characteristics is needed to distinguish between changes during EST in the preexcitation phase. Understanding ECG features related to secondary ST-T wave changes is essential for differentiating between abnormal repolarization in WPW syndrome and acute MI.

Conflict of interest
The authors declare that there is no conflict of interest.

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The authors did not receive any funding for this study.

Ethical statement
Ethical approval for this case study was provided by Dr. Soetomo General Hospital.

Informed consent
A written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review with the Editor-in-Chief of this journal.

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