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IPSILATERAL BLOCK OR CAN A SINGLE ECG BE USED FOR THE DIAGNOSIS?

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Background: *Pre-excitation syndrome (premature excitation of the ventricles) is a congenital anomaly in the structure of the cardiac conduction system and consists in the presence of an additional atrioventricular connection. The possibility to assume the presence of pre-excitation syndrome accompanied by tachycardia based on an electrocardiogram provides a clue to the correct diagnosis and subsequent treatment of the patient.* ***Clinical case description:*** *A clinical case of a 56-year-old patient is presented, who was admitted to the FRCC of the FMBA of Russia in January, 2021 with paroxysms of previously undiagnosed tachycardia. During Holter monitoring, an episode of heart palpitations was recorded. When analyzing an ECG fragment, it was possible, by calculating the tachycardia cycle length, to suspect the presence of a latent ventricular pre-excitation syndrome, which was accompanied by the development of orthodromic atrioventricular reciprocal tachycardia with a bundle branch block on the side of the additional atrioventricular connection (ipsilateral block). The patient underwent endocardial electrophysiological examination to confirm the presence of the bundle, followed by the catheter treatment of the atrioventricular connection. A good postoperative clinical result was obtained.* ***Conclusion:*** *It is important to be able to make a differential diagnosis between the presence of a latent pre-excitation syndrome with the development of orthodromic atrioventricular reciprocal tachycardia with the bundle branch block on the side of the extra atrioventricular junction (ipsilateral block) and other supraventricular tachycardias with an aberration along one of the bundle branches, in order to determine the tactics of the patient management and to control the effectiveness of the treatment.*

Keywords: *WPW syndrome; ipsilateral bundle branch block; paroxysmal orthodromic reciprocal tachycardia; case report; radiofrequency catheter ablation.*

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List of abbreviations

AVRT — atrioventricular reentrant tachycardia
AAVC — additional atrioventricular connection
LBB — left bundle branch
Holter ECG — Holter electrocardiogram monitoring
ECG — electrocardiogram
PQ — interval, measured by ECG, from the beginning of the P wave to the beginning of the Q wave, corresponding to the time of passage of excitation through the atria and atrioventricular node to the ventricular myocardium
QRS — ventricular complex, the largest on the ECG, which is recorded during excitation of the ventricles of the heart
RR — ECG interval between two adjacent R waves
WPW (Wolff, Parkinson, White syndrome) — Wolff, Parkinson, White syndrome

BACKGROUND

Wolff, Parkinson, White syndrome (WPW), or ventricular preexcitation syndrome, is a well-known electrocardiographic pattern (the presence of an additional atrioventricular conduction pathway in combination with tachyarrhythmia) recorded in people with congenital heart disease. In the presence of only classical electrocardiographic signs of ventricular pre-excitation (shortening of the PQ interval less than 120 msec, expansion of the QRS complex by more than 120 msec, the presence of a delta wave), without paroxysms of tachyarrhythmias, one speaks of the WPW phenome-

non. It is the presence of an abnormal atrioventricular junction that is one of the links involved in the formation and maintenance of atrioventricular reentrant tachycardia (AVRT), which, according to the mechanism of occurrence, is reentry tachycardia.

On the basis of electrophysiological mechanisms of WPW syndrome formation, it is customary to distinguish manifesting, intermittent (transient) and latent variants [1].

In the case of registration on the electrocardiogram (ECG) of a delta wave, which reflects the premature excitation of the ventricular myocardium by antegrade (from the atrium to the ventricles) impulse conduction through the additional atrioventricular connection (AAVC), we can talk about the manifest WPW syndrome.

Intermittent WPW syndrome is characterized by the transient onset of ventricular preexcitation symptoms on the ECG, which is manifested by the alternation of normal QRS complexes and deformed QRS complexes with a delta wave.

Identifying the latent WPW syndrome is a significant problem. on the surface ECG, signs of ventricular preexcitation are never recorded. This is due to the inability of the AAVC to conduct electrical impulses in the antegrade direction. In this regard, the diagnosis of latent WPW syndrome is made, as a rule, retrospectively after an endocardial electrophysiological study, during which AAVC is first verified.

However, in rare cases, AVRT in WPW syndrome can be accompanied by a block of one of the bundle branch legs on the side of the AAVC, the so-called ipsilateral block, which has distinctive ECG features [1–4] and allows you to verify the diagnosis of latent WPW syndrome even before the endocardial electrophysiological study.

It is such a rare clinical case that we would like to present to your attention, when, based on one recorded paroxysm of tachycardia, it became possible to accurately diagnose latent WPW syndrome, manifested by the development of orthodromic AVRT in the presence of ipsilateral block.

CLINICAL CASE

About the patient

Patient A., 56 years old, was admitted to the clinic with complaints to episodes of rapid rhythmic heartbeat. Such attacks with a maximum duration of up to 30–40 minutes disturb from 2014 up to 3–4 times a year. They arise suddenly, without provoking factors, are accompanied by severe weakness, stop on their own or are stopped by the use of β-blockers. The heart rate during an attack, with self-measurement, is 150–170 beats/min.

Since 2019, he noted a worsening of the course of the arrhythmic syndrome in the form of an increase in the frequency of episodes of tachycardia up to several times a month, an increase in their duration up to 2 hours.

From the anamnesis it is known about long-term hypertension with maximum blood pressure values of 210/100 mmHg, while taking antihypertensive therapy — 130/80 mm Hg. Since 2018, type 2 diabetes mellitus has been diagnosed with the achievement of target glycated hemoglobin values of less than 7.0% through a low-carb diet.

Instrumental diagnostics

The patient underwent examination aimed at excluding ischemic genesis of arrhythmic syndrome. Diagnostic coronary angiography was performed, according to which no hemodynamically significant stenoses of the coronary arteries were detected. According to the results of echocardiography, no pathology of the valve apparatus was found, the global contractility of the myocardium was not impaired, and the left ventricular ejection fraction was preserved. During the Holter ECG from 01/26/2021, the patient had an attack of rapid heartbeat, which was first recorded on native films (Fig. 1).

Clinical diagnosis

Seeing only this ECG, it became possible to make an accurate diagnosis: “Latent Wolff-Parkinson-White syndrome. Paroxysmal orthodromic atrioventricular reentrant tachycardia involving the left accessory atrioventricular junction.

In this clinical case, we are talking about the latent WPW syndrome, because on all native ECG films previously provided by the patient, classical signs of ventricular pre-excitation were not recorded.

In fig. 1 the first two complexes are sinus, followed by an atrial extrasystole (third complex), which triggers tachycardia with “wide” complexes, which in turn turns into a “narrow complex” tachycardia. The key to the diagnosis is precisely in the combination of “wide-complex” and “narrow-complex” tachycardias on one ECG.

In order to determine the tactics of patient management when registering the above changes on the ECG, it is necessary to carry out differential diagnostics between the development of a block of one of the bundle

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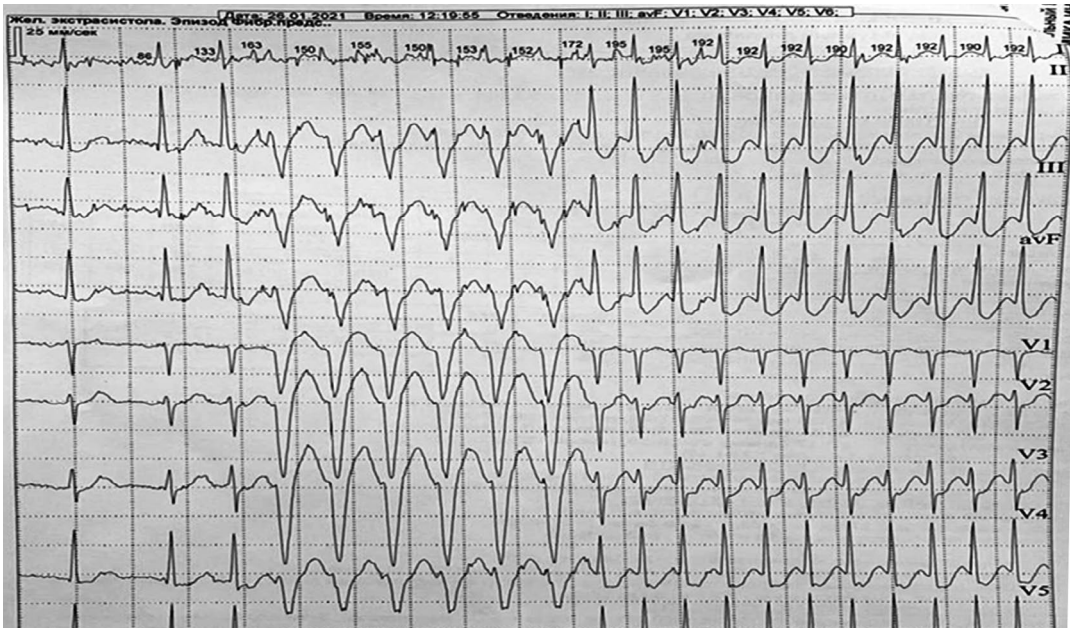
Fig. 1. A fragment of the Holter ECG with the detected paroxysm of tachycardia.



branches in supraventricular tachycardia and ipsilateral block in AVRT in the framework of WPW syndrome.

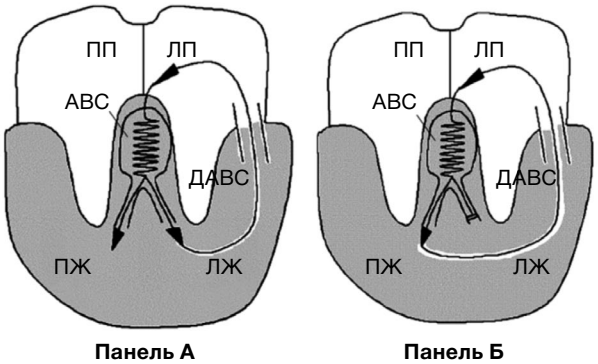
With WPW syndrome, two types of paroxysmal AVRTs may occur — orthodromic and antidromic. In our clinical example, we are talking about orthodromic AVRT.

One of the conditions for the emergence of orthodromic AVRT and the implementation of the reentry mechanism is the presence of two heterogeneous conduction pathways — fast (AAVC) and slow atrioventricular node. The concept of "fast" and "slow" paths include the speed of propagation of the wave of depolarization along the conducting system of the myocardium. The ectopic pacemaker, in this case the atrial extrasystole, blocks the fast conduction path, as a result of which the excitation front from the sinus node is antegradely carried out only along the atrioventricular connection to the conductive system of the bundle of His bundle, meanwhile the AAVC is in the refractory period. While the impulse passes through the "slow" atrioventricular node, conduction along the "fast" AAVC is restored (the additional conduction pathway leaves the refractory state). Excitation, following the conduction system of the bundle branch, is carried out retrograde along the AAVC to the atria with the implementation of the reentry mechanism and registration of the orthodromic AVRT on the surface ECG [5–8] (Fig. 2, panel A). However, in our case, "narrow complex" tachycardia is preceded by a "wide complex" tachycardia of the type of left bundle branch block, which is explained by the presence of an ipsilateral block, which is defined as a bundle branch block on the side of the AAVC (Fig. 2, panel B).

Differential diagnosis

In order to distinguish conduction aberration along the left bundle branch (LBB) in supraventricular tachycardia from orthodromic AVRT with retrograde conduction along AAVC with LBB block, it is necessary to calculate the length of the tachycardia cycle (the distance between two adjacent R-waves of tachycardia,

Fig. 2. Panel A: A diagram of formation of orthodromic atrioventricular reciprocal tachycardia in patients with WPW syndrome. Panel B: A diagram of formation of orthodromic atrioventricular reciprocal tachycardia in the case of ipsilateral (corresponding to the location of the additional atrioventricular connection) bundle branch block.



Note. Here and in Fig. 3: ЛЖ/ПЖ — left /right ventricle; АВС/ДАВС — trioventricular / additional atrioventricular connection.

RR-interval). On the ECG with tachycardia with “narrow” complexes, the RR interval is 315 ms, with tachycardia with “wide” complexes — 400 ms (Fig. 3).

With orthodromic AVRT, accompanied by the appearance of an ipsilateral block of conduction in the left bundle branch system, there is an increase in the RR interval by 85 ms. The difference in RR intervals is that when LBB is blocked, the electrical impulse is redirected to the ventricular myocardium along the right bundle branch, which leads to an increase in the reentry loop and, accordingly, the length of the tachycardia cycle, in contrast to supraventricular tachycardia with a bundle branch block. when the lengthening of the RR-interval does not occur (RR-intervals in «wide-complex» and «narrow-complex» tachycardia will be the same) [3–5].

Thus, on the dismantled fragment of the Holter ECG, an extension of the tachycardia cycle with expansion of the QRS complexes by the type of LBB block is recorded, which indicates the presence of orthodromic AVRT with the participation of the left AAVC (ipsilaterally).

Dynamics and outcome

In February 2021, the patient was admitted to our clinic for catheter treatment — radiofrequency ablation of AAVC.

Electrophysiological diagnostic catheters are positioned through the femoral venous access: 4-pole catheter in the apex of the right ventricle; 10-pole — in the coronary sinus. An electrophysiological study was performed: initially sinus rhythm with a heart rate of 80/min, PQ 192 ms, QRS 98 ms. Signs of ventricular pre-excitation are not recorded. Asynchronous and programmed antegrade pacing from the atrium was performed: the base pacing rate was 500 ms. The antegrade effective refractory period of the atrioventricular junction is 240 ms. Wenckebach antegrade point 360 ms. When conducting asynchronous and programmed retrograde stimulation, the effective refractory period of the AAVC is 320 ms, the retrograde effective refractory period of the atrioventricular junction is 220 ms. On the endogram from the coronary sinus catheter, the approach of the atrial and ventricular potential on the left is determined (Fig. 4).

An access was made to the left atrium by puncture of the interatrial septum, an irrigation radiofrequency ablation catheter was inserted into the left atrium and positioned in the projection of the left lateral AAVC. After obtaining satisfactory electrophysiological parameters (early lead on an ablation catheter, the ratio of atrial and ventricular adhesions in a ratio of 1: 3), 10 radiofrequency applications were performed for 60 seconds each, with an energy of 45 W and a temperature of 45 °C, the parameters of catheter irrigation were 30 ml / min. When conducting a control electrophysiological study, there are no data for the functioning of

Fig. 3. The length of the tachycardia cycle changes from 400 msec to 315 msec. The 85 msec difference corresponds to the increase in the length of the re-entry loop, due to the left bundle branch block. The electric pulse propagates to the myocardium of the ventricles along the right bundle branch only, exciting the right ventricle myocardium, and only later propagates to the left ventricle myocardium.

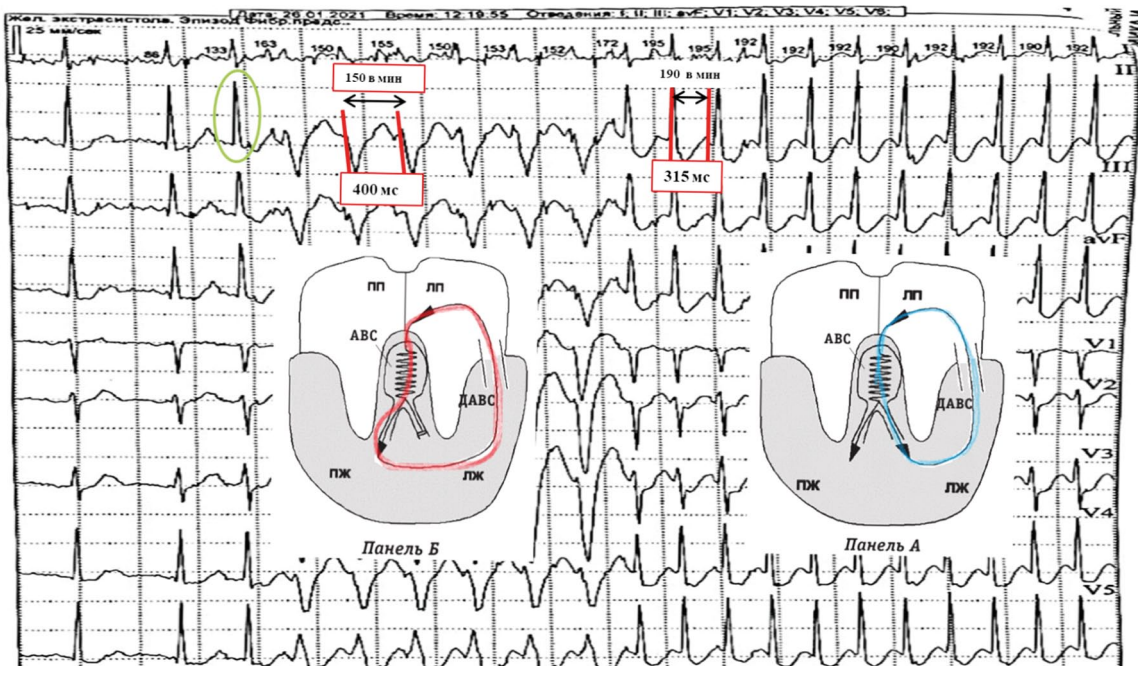


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Fig. 4. Pre-operative electrophysiology study. One can see the atrial and ventricular potentials getting closer (<50 msec) in the region of the left poles of the diagnostic catheter from the coronary sinus (marked with an arrow).

the AAVC (Fig. 5), the Wenckebach antegrade point is 360 ms. Observation — 30 min, followed by control of electrophysiological parameters.

DISCUSSION

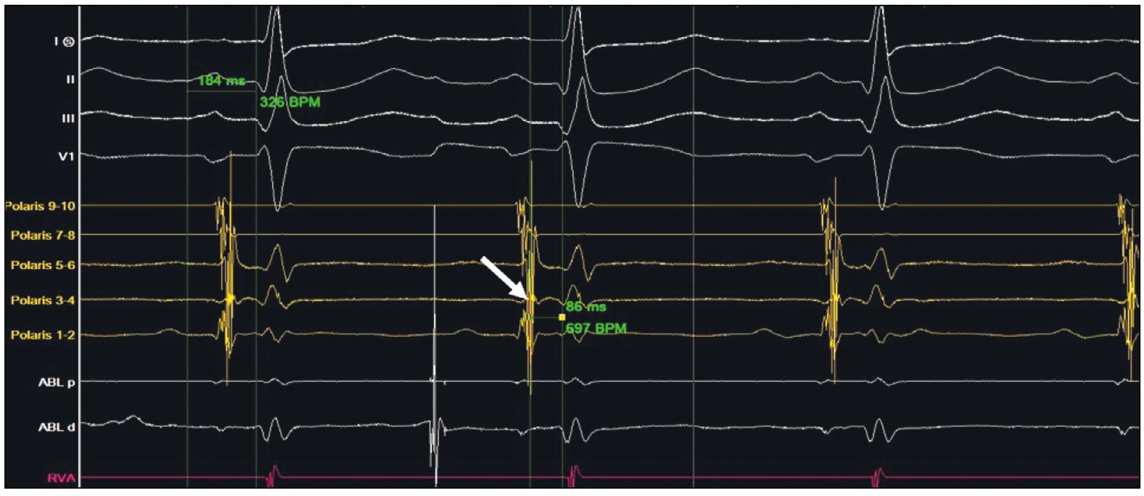
The development of AVRT in latent WPW syndrome, accompanied by ipsilateral block (block of the bundle branch on the side of the AAVC location), recorded on an ECG film, is quite rare in the practice of a cardiologist, which complicates the preliminary clinical diagnosis. Thus, once seeing the transition of "wide-complex" tachycardia to tachycardia with narrow complexes, or, conversely, the transition of tachycardia with narrow complexes to tachycardia with wide complexes, and applying the rule for calculating the length of the tachycardia cycle presented above, it becomes possible to make a correct clinical diagnosis only by one ECG film without the use of additional diagnostic methods.

However, the final method for confirming the electrophysiological substrate of AAVC is an endocardial electrophysiological study. At the same time, the complete elimination of the WPW syndrome is achieved by the widespread introduction of catheter treatment — radiofrequency ablation of AAVC, which improves the patient's quality of life. In other words, without correctly interpreted primary changes on the ECG film, further diagnostic search would be impossible.

CONCLUSION

In the practice of a cardiologist, when it is possible to register the transition of "narrow complex" tachycardia into "wide complex" tachycardia (or vice versa, as in the case described by us) on the ECG or Holter

Fig. 5. Post-operative electrophysiology study. One can see the central type of the conducting system, without signs of an atrioventricular connection (marked with an arrow).



ECG, it is enough to use a simple method of calculating and comparing the RR intervals of “narrow complex” and “wide complex” tachycardia in order to diagnose WPW syndrome with ipsilateral block on the side of the additional atrioventricular junction (in this case, the RR interval of “narrow complex” tachycardia will be less than the RR interval of “wide complex” tachycardia) or to diagnose another supraventricular tachycardia with one bundle aberration His (in this case, the RR-intervals of “narrow-complex” and “wide-complex” tachycardia will be equal).

ADDITIONAL INFORMATION

Author contributions. A.V. Konev — concept of the clinical case presentation, consult of the patient, manuscript writing and editing; D.P. Dundua — patients’ care management, manuscript editing; O.V. Khomiy — literature review, illustrations; E.V. Simonenko —literature search, manuscript writing; S.V. Korolev —intraoperative illustrations. All authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, draft ing and revising the work, fi nal approval of the version to be published and agree to be accountable for all aspects of the work.

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