CASE REPORT

Variation of the PR interval for confirming ventricular pre-excitation on a 12-lead ECG

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Abstract

We present the case of a 14-year-old female patient with recurrent episodes of paroxysmal supraventricular tachycardia (PSVT). Her ECG showed a PR interval of 160 ms in lead II, and a delta wave pattern in leads V2 and V3, with a normal QRS interval of 100 ms. We analyzed the three criteria for confirmation of minimal pre-excitation: (i) absence of a Q wave in V6; (ii) presence of an R wave in V1 and (iii) absence of an R wave in avR. The 3 criteria were not met and failed to establish a diagnosis of ventricular pre-excitation. The electrophysiological study confirmed the presence of a left accessory pathway. A new criterion was analyzed: the variation of the PR interval on the same ECG. A difference of >30 ms was successful to confirm the presence of an accessory pathway before ablation and its absence after catheter ablation.

INTRODUCTION

The classic ECG criteria for pre-excitation syndrome includes: (i) a short PR interval <120 ms, (ii) the presence of a delta wave (slurring of the initial portion of the QRS interval) and (iii) an increased QRS duration of >110 ms. When there is minimal pre-excitation on a 12-lead ECG, the diagnosis of ventricular pre-excitation can be challenging. There are another three criteria to confirm or exclude the presence of an accessory pathway, which include: (i) absence of a Q wave in lead V6, (ii) presence of an R wave in lead V1 and (iii) absence of an R wave in lead avR. In the following patient we studied the three criteria which failed to confirm the presence of an accessory pathway, although the electrophysiological study found a left lateral accessory pathway with orthodromic reentrant tachycardia. We thus analyzed another criterion for the differential diagnosis: the variation of the PR interval which is the difference of the longest PR interval and the shortest PR interval of the 12-lead ECG.

CASE REPORT

A 14-year-old female patient was hospitalized in our Cardiology Department for repeated episodes of PSVT which started at the age of 11. She was treated with Bisoprolol 2.5 mg but presented PSVT despite antiarrhythmic drugs. The 12-lead ECG showed minimal pre-excitation, with a small delta wave in leads V2-V3 but with a normal QRS complex of 100 ms and a normal PR interval in lead II of 160 ms. The three classical criteria for confirmation/exclusion of an accessory pathway were analyzed: there was a Q wave in lead V6, the precordial transition was after lead V1 and a R wave was present in lead avR. Therefore, the three criteria failed to confirm the presence of
an accessory pathway. We measured the longest and the shortest PR interval and found a difference of 40 ms between leads II and V2. (Fig. 1) Before the electrophysiological study, an echocardiogram showed normal ejection fraction and normal dimensions for the cardiac chambers, without any valvulopathy (Fig. 2). During electrophysiological study 4 catheters were introduced through the right femoral vein: a quadripolar catheter at the level of the high right atrium, a quadripolar catheter at the level of the His bundle, a decapolar catheter at the level of the coronary sinus and the ablation catheter at the level of the right ventricle. During ventricular stimulation the retrograde conduction was through a left lateral accessory pathway, which was further confirmed by the activation through the coronary sinus catheter (Fig. 3). As the accessory pathway was lateral, a trans-septal approach was performed using the Brockenbrog needle for the septal puncture (Fig. 4).

After the puncture a sheath was introduced inside the left atrium and a 4 mm tip catheter ablation at the level of the left lateral ring (Fig. 5). Catheter ablation of the accessory pathway was performed using 35 W and 55 C. After ablation there was no anterograde or retrograde conduction through the accessory pathway. After 30 min the procedure was stopped and the patient returned to her room. The 12-lead ECG performed after catheter ablation was compared with the ECG before ablation and the three classical criteria were once again insufficient to establish the presence or absence of an accessory pathway.

Our criteria of PR variation of $>30$ ms confirmed the presence of the accessory pathway before ablation and the absence of the accessory pathway after ablation (Fig. 6). Furthermore an adenosine test was performed to exclude the presence of the accessory pathway after ablation which produced a 2:1 AV block. After ablation the PR interval variation was 5 ms (Fig. 7).
Identification of ventricular pre-excitation syndrome using surface ECG is essential due to the high risk of sudden cardiac death represented by this syndrome [1]. The characteristic ECG elements for this syndrome are: (i) the presence of a short PR interval, (ii) the presence of the delta wave (with slurring of initial portion of the QRS) and (iii) the prolongation of the QRS complex >110 ms [2].

Cases with a normal PR interval are possible in patients with accessory pathways. This may occur due to the presence of a long Kent bundle, localized on the left side with delayed atrial conduction. The PR interval might be at the lower limit of normality (120–130 ms). In our case, the accessory pathway was localized in the far lateral mitral ring.

Diagnostic problems occur when the PR interval is <120 ms, the delta wave is barely visible and the QRS complex is not more than 110 ms. As a solution to this limitation, Bogun et al. [3] claimed that the absence of a septal Q wave in V6 is an indirect sign of pre-excitation. In their study on 37 patients with minimal pre-excitation, while none of the patients presented a septal Q wave prior to treatment, 80% of them recovered it after ablation.

ECG is a non-invasive tool to determining the general location of an accessory [4]. Studies report that patients with left-sided accessory pathways present counterclockwise rotation of QRS transitional zone, more specifically, in lead V1 or prior to that [5]. In their early classification of type A or B pre-excitation, Rosenbaum et al. [6] identified a direct correlation between the presence of left-sided pathways and early horizontal transition in precordial leads. This claim is strengthened by the fact that left free wall pathways cause an earlier activation of the left ventricle, thus generating a right bundle branch block pattern. In the study of Eisenberger et al. [7] on 238 WPW patients, 7% presented a septal R wave in lead avR prior to ablation, and 71% post-treatment. Absence of the R wave in lead avR has a good sensibility for the presence of an accessory pathway.

In unclear cases with minimal pre-excitation, another tool for the ECG diagnosis is the difference between the longest and the shortest PR interval on the same ECG reading. A difference of more than 30 ms in our case was successful in confirming the presence of the accessory pathway before ablation, and excluding it after successful treatment.

**Figure 4:** Fluoroscopic image during trans-septal puncture to access the mitral ring. Red arrow: the needle for trans-septal puncture is inside the left atrium; during injection, the contrast is seen inside the left atrium. Yellow arrow: the coronary sinus catheter. White arrow: the high right atrial catheter.

**Figure 5:** Fluoroscopic image during catheter ablation of the left lateral accessory pathway. Red arrow: the catheter ablation is placed on the lateral mitral ring. Yellow arrow: the coronary sinus catheter. White arrow: the high right atrial catheter.
The use of a selective AV nodal blocking agent (such as adenosine) can non-invasively confirm or exclude a pre-excitation [8]. In our case, 1 day after catheter ablation, the adenosine test revealed a 2:1 AV block that persisted for 6 s after injection. By this test we confirmed the absence of an accessory pathway before the discharge of the patient.

Figure 6: After catheter ablation, the variation of the PR interval is 5 ms (the PR interval in lead II is 120 ms and the PR interval in lead V2 is 115 ms).

Figure 7: Before adenosine injection there is a small wave at the beginning of the QRS interval, which should be differentiated from a delta wave. After adenosine injection there is no conduction through the accessory pathway, 2:1 AV block is present thus excluding the presence of a delta wave.
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CONSENT
Written patient consent to publish has been received; please find the attached consent.

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