Case Report

Concealed WPW Syndrome with Longitudinal Dissociation in the His Bundle Exhibiting Five Different Electrocardiographic Waveforms During Tachycardia

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We examined a patient with concealed WPW syndrome who exhibited five different electrocardiographic waveforms during tachycardia.

With the intracardiac electrogram, all tachycardia were artrioventricular reciprocating tachycardia with retrograde conduction through only the accessory pathway where each artrioventricular conduction form varied: i.e., one with anterograde conduction through the fast pathway, one with anterograde conduction through the slow pathway, one with anterograde conduction through the fast pathway and slow pathway alternately, and an irregular R–R interval, one with anterograde conduction through the fast pathway and wide QRS tachycardia with the right bundle branch block type, and one with anterograde conduction through the fast pathway and wide QRS tachycardia with left bundle branch block.

His bundle electrogram might be split and H, H′ was recorded at the time of sinus rhythm. Furthermore, the right and left bundle branches exhibited a different refractory period because of longitudinal dissociation in the His bundle. Therefore wide QRS tachycardia with both right and left bundle branch block might appear without complete atrioventricular block.

In addition to the association between fast pathway and slow pathway, right and left bundle branch block patterns appeared.

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Key words: WPW syndrome, Various electrocardiogram, Longitudinal dissociation in the His bundle, Artrioventricular reciprocating tachycardia, Dual artrioventricular nodal pathways

Introduction

We examined a patient with concealed WPW syndrome who exhibited various electrocardiographic waveforms during tachycardia.

The patient was a 61-year-old female. She had experienced palpitation attacks for 15 years, both frequency and duration of the attacks increasing over the last 3 months, leading to referral to our Hospital and hospitalization. Nothing remarkable was found in her history or that of her family. No notable abnormalities were found from blood, thoracic simple radiographic images, or echocardiogram.

Findings from Cardioelectrophysiological Study

With premature atrial extrastimulus at the basic

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cycle length of 600 millisecond (ms), the atrioventricular conduction was decremented, followed by artrioventricular reciprocating tachycardia with retrograde conduction through the accessory pathway of anterolateral side of the mitral valve annulus at 330 ms during the connecting period. Further, as a result of shortening the connecting period, the atrioventricular conduction jumped up at 310 ms and conducted anterogradely through the slow pathway. Premature atrial extrastimulus at the basic cycle length of 600 ms during the load of isoproterenol led the atrioventricular conduction to become an aberrant conduction at 340 ms during the connecting period and the surface electrocardiogram showed right bundle branch block type. Further, as a result of shortening the connecting period, an aberrant conduction of the left bundle branch block type was observed at 310 ms during the connecting period at which time a complete atrioventricular block was not detected (**Figure 1**).

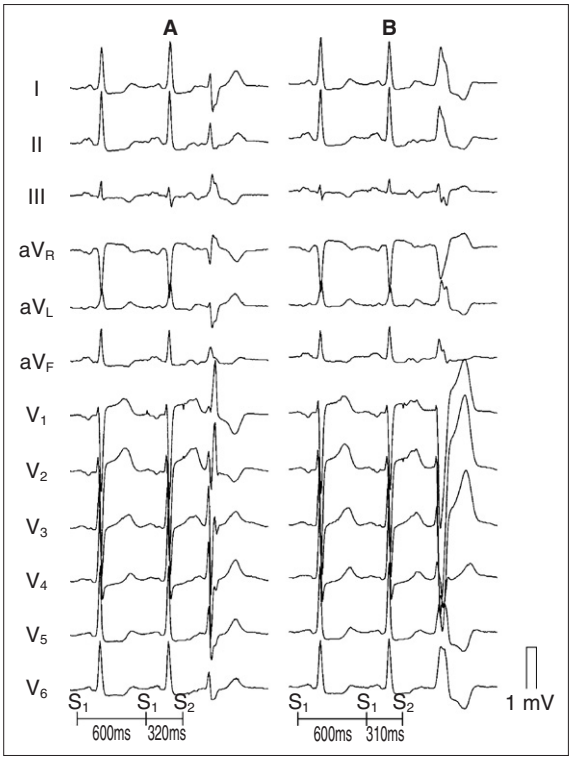

Figure 1 Surface 12-lead electrocardiogram during cardioelectrophysiological study.
A: Premature atrial extrastimulus at 320 ms delivered during a paced atrial basic cycle length of 600 ms. The surface electrocardiogram showed the right bundle branch block type. B: Premature atrial extrastimulus at 310 ms delivered during a paced atrial basic cycle length of 600 ms. The surface electrocardiogram showed left bundle branch block type.
S: stimulus, S_1–S_1: basic cycle length, S_1–S_2: extrastimulus

There were five types of tachycardia induced by the cardioelectrophysiological study on the surface electrocardiogram: 1) supraventricular tachycardia with the heart rate of 183 beats per minute (bpm) (**Figure 2-B**), 2) supraventricular tachycardia with the heart rate of 117 bpm (**Figure 2-C**), 3) supraventricular tachycardia with an irregular R–R interval (**Figure 2-D**); this tachycardia looked like an atrial fibrillation, 4) wide QRS tachycardia with the heart rate of 186 bpm with the right bundle branch block type (**Figure 2-E**), and 5) wide QRS tachycardia with the heart rate 168 bpm with left bundle branch block type (**Figure 2-F**). With the intracardiac electrogram, all tachycardia were artrioventricular reciprocating tachycardia with retrograde conduction with the only accessory pathway through anterolateral side of the mitral valve annulus whereas each type varied with respect to artrioventricular conduction; i.e., one with anterograde conduction through the fast pathway (**Figure 3-B**), one with anterograde conduction through the slow pathway (**Figure 3-C**), one with anterograde conduction through the fast pathway and slow pathway alternately, and an irregular R–R interval (**Figure 5**), one with anterograde conduction through the fast pathway and wide QRS tachycardia with the right bundle branch block type (**Figure 3-D**), and one with anterograde conduction through the fast pathway and wide QRS tachycardia with left bundle branch block type (**Figure 3-E**).

At the time of the sinus rhythm or anterograde conduction through the fast pathway, the His bundle electrogram was split and H, H′ was recorded (**Figure 3-A**). The time between the atrium wave–H′ conduction was 132 ms at the time of narrow QRS tachycardia with anterograde conduction through the fast pathway while it was shorter, i.e., 128 ms, at the time of anterograde conduction through the fast pathway with wide QRS tachycardia, right bundle branch block type. At the time of anterograde conduction through the fast pathway with wide QRS tachycardia with the left bundle branch block type, it was even shorter, i.e., 100 ms (**Figure 3-B, D, E**). During wide QRS tachycardia with right bundle branch block, the conduction time from the His bundle electrogram to the right ventricular apex was longer by 16 ms compared to narrow QRS tachycardia. On the other hand, the conduction time from the His bundle electrogram to the earliest retrograde atrium wave on the accessory pathway of the anterolateral side of the mitral valve annulus was equal and the R–R time was shortened by the time interval between the atrium wave–H′ conduction time (**Figure 3-B, D**). During wide QRS tachycardia with left bundle branch block, the conduction time from the His bundle electrogram to the right

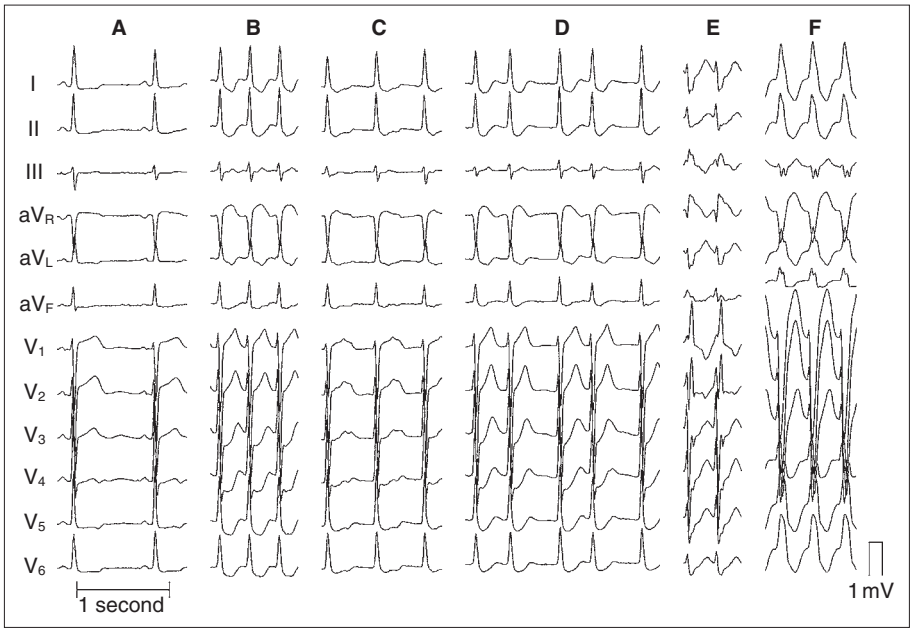

Figure 2 Results of surface 12-lead electrocardiogram during sinus rhythm and tachycardia. Various artrioventricular reciprocating tachycardias were observed as follows.
A: Sinus rhythm. B: Narrow QRS supraventricular tachycardia of the fast rate type with the heart rate of 183 bpm. C: Narrow QRS supraventricular tachycardia of the slow rate type with the heart rate of 117 bpm. D: Narrow QRS supraventricular tachycardia with an irregular R–R interval. E: Wide QRS tachycardia of the right bundle branch block type with the heart rate of 186 bpm. F: Wide QRS tachycardia of the left bundle branch block type with the heart rate of 168 bpm.

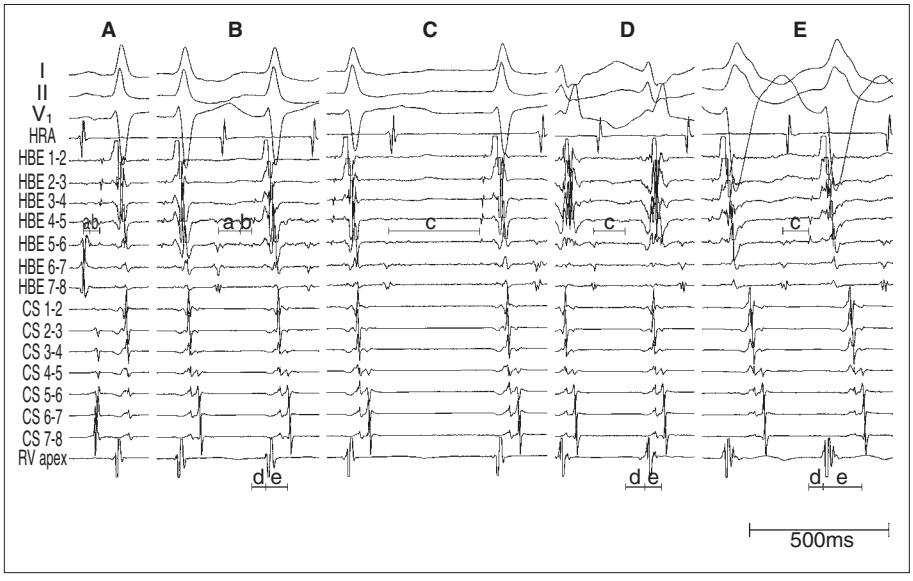

Figure 3 Intracardiac electrogram during sinus rhythm and artrioventricular reciprocating tachycardia.
a: atrium wave–H conduction time, b: H–H′ conduction time, c: atrium wave–H′ conduction time, d: H′–RV apex conduction time, e: RV apex–retrograde atrium wave on the accessory pathway conduction time
A: Sinus rhythm. a: 20 ms, b: 37 ms. B: Tachycardia with anterograde conduction through the fast pathway. R–R interval: 327 ms, a: 75 ms, b: 57 ms, d: 54 ms, e: 73 ms. C: Tachycardia with anterograde conduction through the slow pathway. R–R interval: 512 ms, c: 340 ms. D: Tachycardia with the right bundle branch block type. R–R interval: 323 ms, c: 128 ms, d: 70 ms, e: 57 ms. E: Tachycardia of the left bundle branch block type. R–R interval: 360 ms, c: 100 ms, d: 54 ms, e: 138 ms.
HRA: high right atrium, HBE: His bundle electrogram, CS: coronary sinus, RV: right ventricle

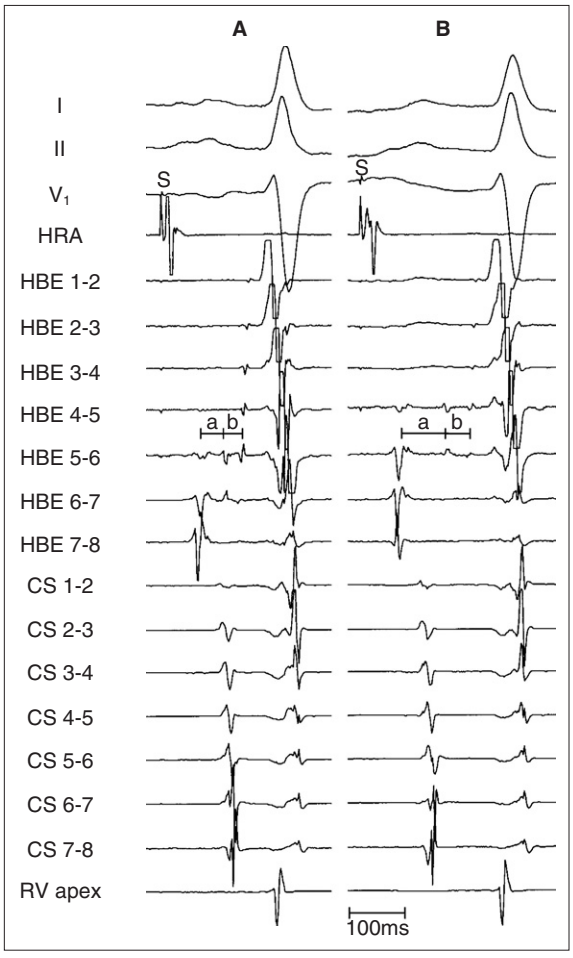

Figure 4 Intracardiac electrogram during cardioelectrophysiological study.
a: atrium wave–H conduction time, b: H–H′ conduction time
A: atrial burst pacing at 600 ms. a: 50 ms, b: 30 ms. B: atrial burst pacing at 400 ms. a: 80 ms, b: 50 ms.
S: stimulus

ventricular apex was the same as that of the narrow QRS tachycardia while the conduction time from the right ventricular apex to the earliest retrograde atrium wave on the accessory pathway of anterolateral side of the mitral valve annulus was prolonged by 65 ms; therefore the R–R time was prolonged by 33 ms despite the shortening of the atrium wave–H′ conduction time interval (**Figure 3-B, E**).

After interruption of the single accessory pathway using catheter ablation, none of the tachycardia including the atrioventricular nodal reentrant tachycardia could be induced.

At the time of the sinus rhythm or anterograde conduction through the fast pathway, the His bundle electrogram was split and H, H′ was recorded while, at the time of the artrioventricular reciprocating tachycardia with anterograde conduction through the fast pathway, the time for H–H′ conduction was prolonged from 37 ms to 57 ms, compared to sinus rhythm (**Figure 3-A, B**). At the time of atrial burst pacing at 400 ms, the time for atrium wave–H conduction became prolonged, as well as prolongation of the H–H′ conduction time from 30 ms to 50 ms, compared to atrial burst pacing at 600 ms (**Figure 4**). Patterns of atrioventricular conduction were similar at pre and post ablation.

During artrioventricular reciprocating tachycardia with an irregular R–R interval, H′ was recorded with anterograde conduction through the slow pathway while both H and H′ were recorded with anterograde conduction through the fast pathway (**Figure 5**).

Discussion

It was considered that during the artrioventricular reciprocating tachycardia, irregular R–R interval was observed because anterograde conduction through the fast pathway and slow pathway was applied alternately during the refractory period interval.

When A–H interval became shorter because of the acceleration of tachycardia, narrow QRS changed to wide QRS, right bundle branch block type. When A–H interval became much shorter, wide QRS, left bundle branch block type was observed. However, R–R interval of tachycardia with left bundle branch block was longer compared to that of right bundle branch block because the conduction time from the right bundle branch to accessory pathway of the anterolateral side of the mitral valve annulus was longer.

His bundle electrogram might be split and H, H′ was recorded at the time of sinus rhythm. Furthermore, right and left bundle branches were able to exhibit different refractory periods because of longitudinal dissociation in the His bundle. The right bundle branch which occurred during the refractory period previously resumed conduction during the refractory period of the left bundle branch. Therefore wide QRS tachycardia with both right and left bundle branch block might appear without complete atrioventricular block.[1)] H′–RV apex conduction time during tachycardia with the right bundle branch block type prolonged comparison with narrow QRS tachycardia. However, H′–RV apex conduction time during tachycardia with left bundle branch block again became same interval during narrow QRS tachycardia. Therefore conduction of the right bundle branch was considered to recur during tachycardia with left bundle branch block.

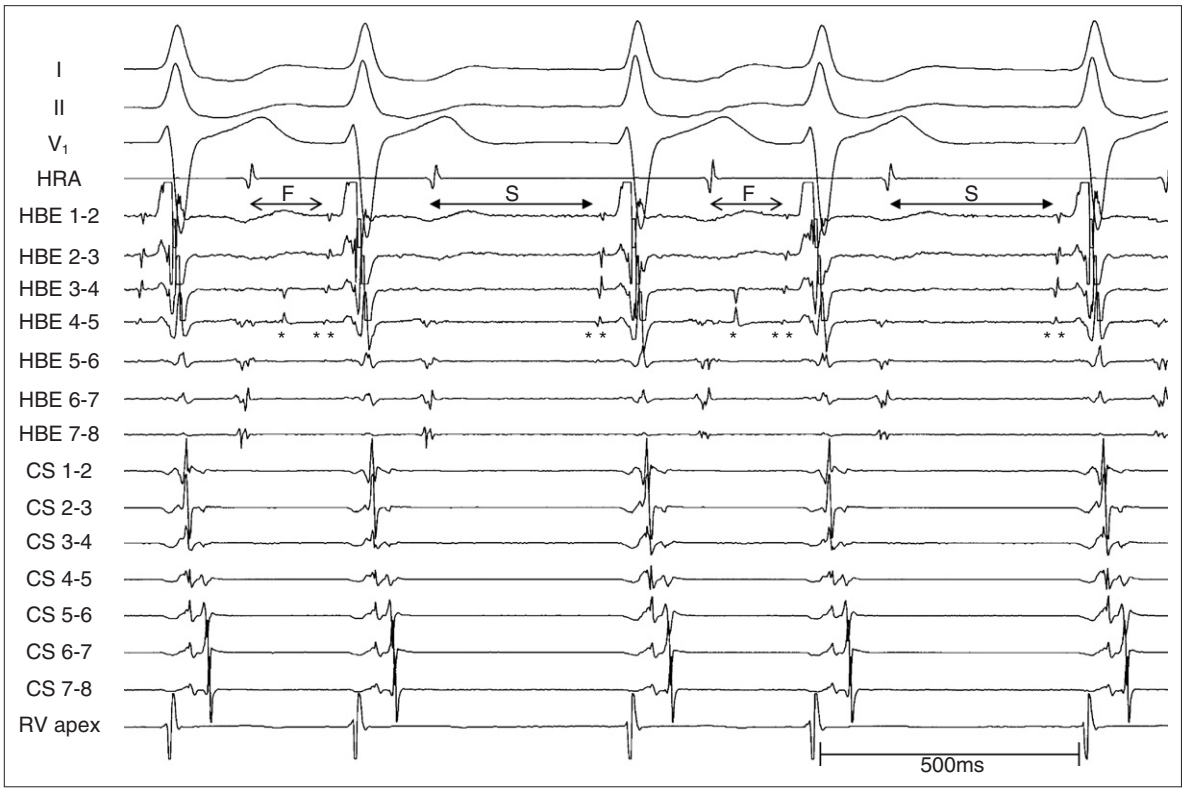

Figure 5 Shows the results of intracardiac electrogram during the artrioventricular reciprocating tachycardia with an irregular R–R interval.
The retrograde conduction passed through only one accessory pathway, whereas the anterograde conduction passed through the fast pathway and slow pathway alternately.
∗: H, ∗∗: H′, arrow S: anterograde conduction through the slow pathway, arrow F: anterograde conduction through the fast pathway

The dissociation space in His bundle was considered to be connected by a slow conduction zone because H–H′ conduction time was prolonged by the fast heart rate.

Because H′ was recorded with anterograde conduction through the slow pathway while both H and H′ were recorded with anterograde conduction through the fast pathway at the time of the artrioventricular reciprocating tachycardia with an irregular R–R interval, slow pathway was considered to input into H′ on the posterior longitudinally dissociated His bundle directly.

Conclusion

Although four types of waveforms on the surface electrocardiogram during artrioventricular reciprocating tachycardia with retrograde conduction through the accessory pathway has been reported in cases with concealed WPW syndrome,[2] our case interestingly revealed five types of waveforms.

In addition to the association between fast pathway and slow pathway, right and left bundle branch block patterns appeared because of longitudinal dissociation in the His bundle and various electrocardiographic complexes could be observed.

References

1) Tanaka H, Igawa O, Adachi M, Suga T, Yana A, Miake J, Inoue Y, Yamanouchi Y, Ogura K, Kato K, Hisatome I, Shigemasa C: A case with advanced atrioventricular block that represented various types of atrioventricular conduction and was suspected to longitudinal dissociation in the His bundle. Journal of arrhythmia 2001; 17: 279
2) Osada K, Nakazawa K, Matsumoto N, Kishi R, Takagi A, Sakurai T, Miyake F: A case of tachycardia with various electrocardiographic morphologies vanishing by a one point catheter ablation. St Marianna Med J 2000; 28: 159–164