Absence of Left Atrium-Coronary Sinus Musculature Electrical Connection at Coronary Sinus Ostium Unmasked by Unique Double Coronary Sinus Potentials Pattern

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Abstract

We describe a 77-year-old man with Wolff-Parkinson-White syndrome exhibiting double coronary sinus (CS) potentials during retrograde conduction over accessory pathway (AP). The first, low-frequency potential (DP1) was first recorded in the left posterolateral region, while the second, higher frequency signal (DP2) was recorded in a lateral-to-septal direction. The two signals were fused near the left lateral wall. Successful ablation of the AP was obtained at its ventricular insertion site in the postero-septal region. The unexpectedly delayed activation of the paraseptal RA following activation of the paraseptal left atrium (DP1) can be explained by the absence of a LA-CS musculature (CSM) electrical connection at the proximal CS, which forces a detour of the activation wavefront from LA to RA via the distal CS (DP2). This is a rare case exhibiting unique double CS potentials which unmasked the absence of a LA-CSM electrical connection at CS ostium.

Key words: interatrial conduction, coronary sinus mapping, accessory atrioventricular pathway, Wolff-Parkinson-White syndrome, double potentials


Introduction

Coronary sinus (CS) musculature (CSM) is usually connected to the left atrium (LA), creating an interatrial electrical connection at CS ostium (1, 2). Electrophysiological analysis of CS recordings which represent far-field activation of LA and near-field activation of CSM, is useful to investigate CSM-LA electrical connections (3-6). Since multiple CSM-LA connections are generally present (3), CS recordings of retrograde conduction through a left-sided accessory pathway (AP) typically show a single atrial signal, due to fusion of the LA and CSM potentials. However, in some patients, double potentials representing LA and CSM activation are recorded along the CS during retrograde AP conduction only due to a few LA-CSM electrical connections (3). We describe a rare case exhibiting unique double CS potentials which unmasked the absence of a LA-CSM electrical connection at CS ostium.

Case Report

A 77-year-old man with a history of atrial fibrillation and ventricular preexcitation was hospitalized for catheter ablation of atrioventricular (AV) AP. A delta wave with positive polarity in lead V1 and negative polarity in leads II, III and aVF was present on the 12-lead electrocardiogram (ECG) during sinus rhythm (Fig. 1). Standard catheters were placed in the high right atrium (HRA), His-bundle region and at the right ventricular apex (RVA), and poles 9-10 of a decapolar...
catheter with 5-mm interelectrode spacing were placed at the CS ostium for electrophysiologic studies. Atrial extrastimulation showed non-decremental conduction across the AP and a 280-ms effective refractory period, unchanged by a 20-mg i.v. bolus of adenosine. During RVA pacing, double potentials were recorded along the CS (Fig. 2). The first, low-amplitude, low-frequency potential (DP1) was recorded in the left posterolateral region (CS 3-4 or 4-5), followed by activation of low and HRA, while the second, higher-amplitude, higher frequency signal (DP2) was recorded sequentially from the left lateral region (CS1-2) to the CS ostium (CS 9-10). The two signals were fused near the left lateral wall (CS 1-2). Retrograde P waves were not visible on the 12-lead ECG during RVA pacing. We found no “far-field” ventricular electrogram preceding the onset of the delta wave on any of the CS recordings (Fig. 3), suggesting that the ventricular insertion of the AP was away from the left free wall.

A 7F deflectable 4-pole catheter with an 8-mm tip electrode (Navistar™ DS, Biosense Webster, Inc., Diamond Bar, CA, USA) was introduced via the right femoral vein for ablation. When mapping the tricuspid annulus, we detected ventricular activation preceding the delta wave during sinus rhythm in the right postero-septal region. Several applications of radiofrequency energy anterior or inferior to the CS ostium failed to eliminate AP conduction, though caused a marked change in the polarity of the delta wave, suggesting the presence of multiple AP, or multiple components of a single AP. Finally, we detected the earliest ventricular activation during sinus rhythm within the terminal 1 cm of the CS ostium, where the delivery of RF energy for 10.7 seconds eliminated AP conduction on a power of 17 W, a temperature of 39°C and an impedance of 64 Ohm, (Fig. 3, 4), suggesting a septal ventricular insertion of the AP. After the elimination of AP conduction, no ventriculo-atrial conduction was observed during RVA pacing.

Discussion

We attributed DP1 and DP2 to the activation of LA and CSM, respectively, on the basis of the following observations: The morphology of DP1 is consistent with a LA “far-field” potential, while that of DP2 is consistent with the activation of the CSM (1, 3-6). The LA activation earlier than a) the CSM and b) the atrium in the His-bundle region during RVA pacing suggested the presence of an AV AP, rather than a CSM-ventricular AP. The atrial insertion of the AP was located in the LA posterolateral region where the earliest DP1 was recorded (CS 3-4 or 4-5). Regarding the ventricular insertion of the AP, we identified the site of the ventricular activation preceding the onset of delta wave in the posteroseptal region, leading to the diagnosis of posteroseptal AP. Based on the positive polarity of lead V1, the present case was classified as an electocardiographically “left-sided” AP irrespective of the actual location of the ventricular insertion of the AP (7), which can often be ablated from a right atrial approach (8). These electrocardiographical and electrophysiological observations indicate that the AP was obliquely oriented (9), with its ventricular insertion in the posteroseptal region and its atrial insertion in the left posterolateral wall and was ablated at the ventricular insertion.
from a right atrial approach.

Although atrial activation during retrograde AP conduction occurred from the left posteroseptal region, CSM activation was in a distal-to-proximal sequence which appeared to be unique. We noted that, before the elimination of AP conduction, the atrial deflection recorded at the site of successful ablation during RVA pacing followed DP1 as well as the latest DP2 (Fig. 2). Considering the fusion of DP1 and DP2 limited to the distal CS recordings which suggested that the LA-CSM electrical connection was confined to the left lateral wall, the unexpectedly delayed activation of the paraseptal RA following activation of the paraseptal LA can be explained by the absence of a LA-CSM electrical connection at the proximal CS, which forces a detour of the activation wavefront from LA to RA via the distal CS (Fig. 5, Panel A). In contrast, during sinus rhythm, large single potentials were observed along the CS recordings (Fig. 3). The activation of the CSM from the RA to the left lateral and neighboring LA, probably occurring via other interatrial electrical connection, such as Bachmann’s bundle and the interatrial septum, is fused along the CS (Fig. 5, Panel B). If the LA-CSM electrical connection at the proximal CS is present, as shown in Panel C of Fig. 5, the waveform of LA (DP1) would reach the ostium of CS, and the waveform

**Figure 2.** Double potentials along the coronary sinus (CS) recorded at 100 (A) and 400 (B) mm/sec paper speed, during right ventricular apex (RVA) pacing at 600-ms cycle length. Low-amplitude, low-frequency DP1 (unfilled arrows) are recorded from the earliest DP1 (CS 3-4 or 4-5) with later lateral activation, while the higher-amplitude, higher frequency DP2 (filled arrow) are activated in a distal-to-proximal CS sequence. The peak of DP1 recorded earlier at CS3-4 and CS4-5 than at CS2-3 and CS1-2, and the reversal of initial polarity observed between CS3-4 and CS4-5, indicates that the earliest DP1 is recorded at CS3-4 or CS4-5. DP1 and DP2 are fused at CS 1-2. Thus, during retrograde AP conduction, the atrial wavefront (DP1) originating from the posterolateral atrium (CS3-4 and CS4-5) propagates to the CSM from the distal CS (CS1-2), followed by CSM activation (DP2) from the distal (CS1-2) to the proximal CS (CS9-10). The atrial electrogram in the His-bundle region follows DP1, consistent with retrograde atrial activation via a left-sided AP and subsequently Bachman’s bundle, interatrial septum or both. Note that the atrial electrogram recorded from ABL1-2, located in the right-sided posteroseptal region (the successful ablation site in Figure 3, and Panel A and B of Figure 4), appears after DP1 and DP2, suggesting that the atrial insertion of the AP is on the left side of the septum, instead of the right posteroseptal region. Pacing study was not performed to investigate the genesis of double potentials recorded in CS9-10. I, II III, aV1, V1, V3, and V5 = surface electrocardiogram; HRA 3-4 = high right atrium; HBE 1-2 = distal His-bundle regions; ABL 3-4 and 1-2; proximal and distal ablation catheter recordings, respectively; CS 9-10 to 1-2 = proximal to distal CS recordings; RVA 3-4 = right ventricular apex; S1= stimulus artifact.
through the CSM (DP2) would subsequently propagate in a proximal-to-distal direction. However, this hypothesis would be neglected due to the absence of the wavefront of DP2 in a proximal-to-distal direction.

Histological study in humans has shown that myocardial connections between LA and CSM varies greatly in size and location, and no connection or a loose connection in the distal CS is not rare (2). In contrast, the absence of LA-CSM...
The authors state that they have no Conflict of Interest (COI).

References


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