A case of concealed inferior vena cava bigeminy in a patient of atrial fibrillation

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June 21, 2023

Abstract

We report a case of atrial fibrillation with frequent monomorphic atrial premature contractions (APCs) in which P-wave morphology was negative in II, III, and aVF and positive in I and aVL leads. After pulmonary vein isolation using a cryoballoon, high-resolution electroanatomical mapping revealed ectopic beats from the posteroseptal area within the inferior vena cava (IVC) with concealed bigeminy. Catheter ablation just above the ectopic focus eliminated the APC with residual dissociated activity inside the IVC. This is the first report to reveal continuous ectopic bigeminy definitely originating from the tiny area within the IVC by detailed three-dimensional mapping.

A case of concealed inferior vena cava bigeminy in a patient of atrial fibrillation

Short title: Concealed IVC bigeminy

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Funding: none

Conflict of interest: RS: None, SY: None, HO: None, KT: None, MY and TY: There is no COI to disclose directly related to this study.

Key words: Atrial fibrillation, Catheter ablation, Inferior vena cava, Concealed bigeminy

Abstract

We report a case of atrial fibrillation with frequent monomorphic atrial premature contractions (APCs) in which P-wave morphology was negative in II, III, and aVF and positive in I and aVL leads. After pulmonary vein isolation using a cryoballoon, high-resolution electroanatomical mapping revealed ectopic beats from the posteroseptal area within the inferior vena cava (IVC) with concealed bigeminy. Catheter ablation just

above the ectopic focus eliminated the APC with residual dissociated activity inside the IVC. This is the first report to reveal continuous ectopic bigeminy definitely originating from the tiny area within the IVC by detailed three-dimensional mapping.

Case presentation

We herein report a male in his 40s who was referred for catheter ablation due to drug refractory paroxysmal atrial fibrillation (PAF) and frequent atrial premature contractions (APCs). Informed consent was obtained from the patient for publication of this case report. An electrocardiogram recording of the APCs demonstrated a negative P-wave morphology in the inferior leads and a positive P-wave morphology in the I and aVL leads **(Figure 1A)** . Other examinations, including a cardiac echocardiogram, chest X-ray, and laboratory tests, showed results within the normal range. After successful pulmonary vein isolation using a third-generation cryoballoon system (Arctic Front Advance Cardiac Cryoablation Catheter, Medtronic), frequent mono-morphological APCs remained. We therefore mapped the APC focus with a multielectrode mapping catheter (PentaRay; Boisense Webster, Diamond Bar, CA, USA) on a high-density three-dimensional electroanatomical mapping (3D-EAM) system (CARTO3; Boisense Webster). The activation map showed a focal activation pattern from the inferior vena cava (IVC). The earliest activation site was located at the posteromedial part within the IVC (6.2 mm below the IVC ostium), and the local signal demonstrated a very low amplitude of 0.05 mV (**Figure 1B**). In addition, the voltage map (>0.05 mV) demonstrated the short IVC sleeve from the ostium (9.3 mm) **(Figure 1C)** . Interestingly, sustained continuous IVC firings (bigeminy) were observed, which propagated to the right atrium (RA) only when the coupling interval was prolonged from 190 msec to 200 msec **(Figure 2)** . We next mapped the concealed bigeminy alone, which revealed the confined tiny excitable area within the IVC (0.1 cm^2) with low-voltage fragmented potentials recorded at the earliest site **(Figure 3A and 3B)** . Catheter ablation was performed at the transit area between the IVC and RA to isolate the IVC. The APCs and concealed IVC firings disappeared after a total of 4 radiofrequency applications (30 W, 192 seconds), and dissociated activity was observed immediately after IVC isolation. After four months of follow-up, there was no AF recurrence without any anti-arrhythmic drug, and the number of APCs was within normal limits.

Discussion

Although IVC is known as a possible source of non-PV foci in AF patients, the prevalence is very low. Nie et al. recently reported from a single center that the incidence of AF triggered from the IVC was 0.91% (6/661).[1] However, a total of only 7 isolated reports (8 cases) had been reported as of July 2022.[2-8] In line with the rarity of previously published cases, there were only 2 cases (0.04%) among 4,500 AF ablation procedures in our hospital.[4] Thus, the prevalence of AF triggers in the IVC is considered to be much lower in the real world than the recent report.[1]

Hashizume et al. described that the IVC histologically has the same arrhythmogenicity as the thoracic veins (PVs, superior vena cava [SVC], coronary sinus) with cardiac musculature extending from the RA in humans. However, the myocardial sleeve in the IVC was much shorter than that in the SVC (18 mm vs. 45 mm).[9] In addition, the IVC is considered to be electrically more silent than the SVC because of the frequent absence of longitudinal myocardial fibers.[10] These different electrophysiological features may relate to different developmental processes between the two venous systems; the SVC is embryologically derived from the anterior cardinal vein, whereas the terminal segment of the IVC is derived from the right vitelline vein.[11]

In the clinical setting, the precise localization of the APC origin in the IVC is often difficult due to the proximity of the coronary sinus ostium and lower part of the RA. In previous reports, although nine cases anatomically demonstrated the origin of the trigger from the IVC using a contact 3D-EAM system, the definition of the border between the IVC and RA was unclear.[1,6-8] In the present case, the concealed IVC firings (bigeminy) observed in the IVC strongly suggested an origin inside the IVC rather than at the RA-IVC junction. This is the first case demonstrating the limited excitation area with a low voltage in the IVC by detailed 3D-EAM.

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Figure legends

Figure 1. (A) P-wave morphology of atrial premature contraction (APC) in a 12-lead electrogardiogram. (B) The activation map of the APCs demonstrated a focal pattern originating from the posteromedial inferior vena cava (IVC) ostium. The earliest activation site was located 6.2 mm below the IVC ostium, and (C) a local signal with a fragmented and low amplitude (0.05 mV) was recorded. CS, coronary sinus; IVC, inferior vena cava; SVC, superior vena cava.

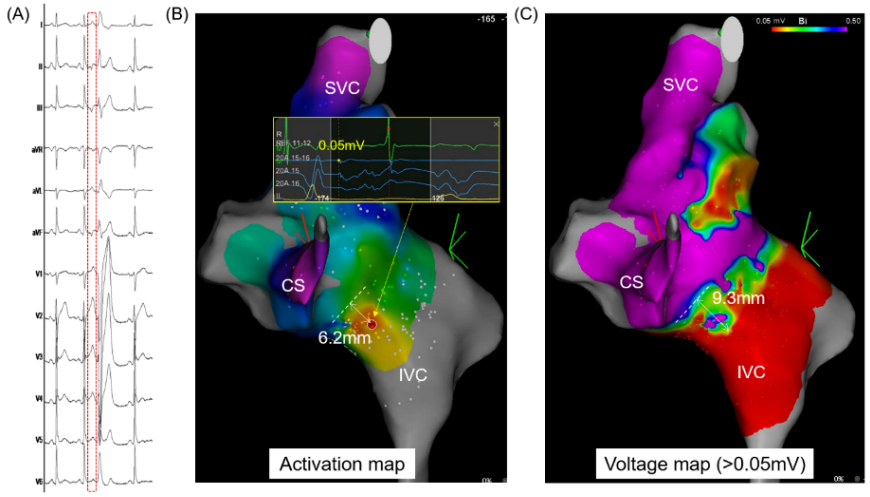

Figure 2. The electrogram of concealed IVC bigeminy with transient conduction to the atrium. The concealed IVC bigeminy (asterisk) propagated to the atria when the coupling interval was extended from 190 to 200 msec (arrow). AP, anteroposterior view; CSd, coronary sinus distal; CSp, coronary sinus proximal; LAO, left anterior oblique view; PR; PentaRay catheter.

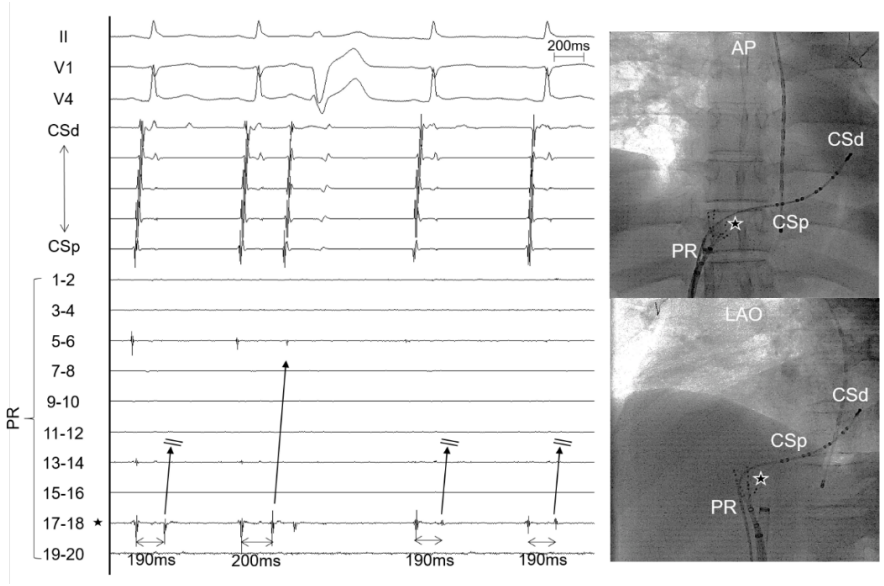

Figure 3. (A)(B) The activation and voltage maps of concealed IVC bigeminy. Continuous concealed IVC bigeminy was observed in the limited excitable area (0.1 cm^2) with fragmented low-voltage signals within the IVC. CS, coronary sinus; IVC, inferior vena cava; SVC, superior vena cava.