Local abnormal atrial activity related to right septal intra-atrial reentrant tachycardia after mitral valve surgery

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Introduction
Substrate-based catheter ablation (CA) during sinus rhythm has been recently reported as a useful therapeutic option for patients with either atrial1,2 or ventricular3,4 tachyarrhythmias. As a therapeutic target for ventricular tachycardia (VT), elimination of local abnormal ventricular activities (LAVAs) during sinus rhythm or ventricular pacing has been reported to be a useful and effective endpoint for substrate-based VT ablation.5 However, there are limited published reports regarding local abnormal activity with a decremental property in the field of atrial tachycardia (AT). Herein, we report a patient with local abnormal atrial activity (LAATA)-related intra-atrial reentrant tachycardia (IART) recorded at the posterior septum of the right atrium (RA), which was located at the opposite side of a prior direct left atriotomy incision.

Case report
A 64-year-old man, who had previously undergone mitral valve surgery, was referred to our institution for CA of recurrent AT. Four years earlier, he had undergone mechanical mitral valve replacement via a direct left atriotomy. Nine months after valve replacement surgery, in another hospital, he had undergone his first CA session, using radiofrequency (RF) energy, for cavotricuspid isthmus (CTI)-dependent atrial flutter. During his second CA session, after admission to our institution, RF energy ablation of a CTI reconduction gap was performed. After CTI block was reconfirmed using a differential pacing method, a low-voltage (<0.5 mV) zone (LVZ) in the RA posterior septum was observed, using a PentaRay® NAV (PentaRay) catheter (Biosense Webster, Diamond Bar, CA), in the voltage map during sinus rhythm (Figure 1A). AT, with a cycle length (CL) of 250 ms, was induced using atrial program stimulations at the proximal site (CS 9-10) of a 10-polar electrode catheter positioned in the coronary sinus. Of note, upon AT initiation, a LAATA with a decremental property during atrial program stimulation was recorded using a PentaRay catheter positioned in the lower posterior RA septum (Figure 1B–D). An activation map during AT, using 3-dimensional electroanatomical

KEY TEACHING POINTS

• Substrate-based ablation can be an effective approach for both atrial and ventricular tachyarrhythmias. Low-voltage zones (LVZs) and local abnormal potentials have attracted attention as therapeutic targets.

• Local abnormal atrial activities with a decremental property related to the tachycardia circuit can be unmasked using atrial programmed stimulation in patients with atrial tachycardia, similar to local abnormal ventricular activities in those with ventricular tachycardia.

• In patients who have undergone mitral valve surgery, via a direct atriotomy, some areas with LVZ may be formed in the right atrium, through the atrial septum, on the side opposite the surgical incision. These surgical procedure–associated LVZ areas, even if they are not incisional sites, might be associated with occurrence of intra-atrial reentrant tachycardia after surgery.

KEYWORDS Cardiac surgery; Decremental property; Direct left atriotomy; Intra-atrial reentrant tachycardia; Local abnormal atrial activity; Substrate-based ablation
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mapping (CARTO3; Biosense Webster), revealed that tachycardia propagated upward from the lower to the upper posterior RA septum, along the narrow conduction channel of the circuit (Figure 2), and was diagnosed as an IART on the basis of its mechanism. The postpacing interval was not obtained at the conduction channel of the tachycardia circuit, located in the lower and mid-posterior RA, owing to noncapture of the local myocardium or AT termination by pacing. During AT, pacing with a CL of 230 ms at the distal tip of the ablation catheter, positioned in the upper posterior RA septum, entrained tachycardia with concealed fusion (Figure 3A). The postspacing interval at this site was 266 ms, which approximated (within 20 ms) the AT CL (250 ms), and indicated participation of the upper posterior RA septum in the IART circuit. When RF energy was delivered, targeting the conduction channel of the IART circuit in the upper posterior RA septum, the AT was terminated following slowing of the AT CL (Figure 3B–D). Additionally, to prevent AT recurrence propagating around the LVZ, a linear lesion was created from the termination site, along the conduction channel of the IART circuit in the upper RA septum, connecting to the superior vena cava. Finally, further atrial arrhythmias were not induced by programmed electrical stimulation with isoproterenol infusion. During a 12-month follow-up, the patient remained free from atrial tachyarrhythmia recurrence, without requiring antiarrhythmic medication.

**Discussion**

Substrate modifications targeting LAVAs for scar-related VTs have been reported to result in substantial reduction in VT storms and implantable cardioverter-defibrillator shocks during both short- and long-term follow-ups. The local abnormal electrograms, called LAVAs, are characterized by measuring the signal amplitude and local delay, with reference to the far-field ventricular electrogram and the end of the QRS complex on the surface electrocardiogram. Programmed electrical stimulation from the right ventricle...
unmasks the LAVA potential by increasing the delay from the far-field signal. In the present case, similar to the LAVA potential, atrial program stimulation from the proximal side of the coronary sinus was able to separate the LAATA, with an increasing conduction delay from the far-field atrial signal. To the best of our knowledge, the present case is the first to clearly illustrate a LAATA with a decremental property related to the IART circuit using atrial programmed stimulation.

Of note, the LVZ, which might play a critical role in the maintenance of IART in the present case, was located on the opposite side of a previous left atriotomy surgical site, through the atrial septum. A previous report demonstrated that the LVZs resulting from atriotomy scars or cannulation sites often provide a substrate for macroreentrant arrhythmias. Additionally, focal ATs may arise from sites adjacent to abnormal tissue or related to suture lines. We speculate that the LVZ in the RA septum, in the present case, might have been caused by the adjacent tissue damage that resulted from the previous surgical incision and/or procedure. The findings of the present case indicate the importance of elaborate and precise mapping, throughout the RA, during post-cardiac surgery CA for AT, even if the previous surgery was performed via a direct left atriotomy.

There are some limitations to the electrophysiological study in the present case. We could not assess entrainment mapping at the posterior lower septum of the RA, where the LAATA was recorded, owing to loss of local myocardial capture and AT termination by pacing. The decremental property may have not been a firm evidence of the relationship between the LAATA and circuit of IART. Moreover, 3-dimensional mapping of the left atrium was not performed. However, we suggest that the AT circuit, in the present case, is valid for the following reasons: entrainment with concealed fusion during AT was obtained by pacing from the RA, and AT was terminated by the delivery of RF energy to the upper septum of the RA. Further multiple-case studies of IART are required to clarify the frequency of LAATA recording, and its electrophysiological characteristics and association with the circuit of reentry.

**Conclusion**

We encountered an IART case with a LAATA recorded in the septum of the RA after mitral valve surgery involving a direct left atriotomy. Both the LVZ and LAATA during sinus rhythm were recorded near a narrow conduction channel during the IART. They were located on the side opposite the surgical incision of left atrium across the atrial septum. Substrate-based ablation targeting the LAATA, using elaborate high-density mapping and atrial program stimulation, can be a therapeutic option for achieving better outcomes.
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