The impact of left atrial inferior wall isolation, in addition to pulmonary veins and left posterior wall, on long-standing persistent atrial fibrillation

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Introduction

Catheter ablation (CA) is an effective treatment strategy for paroxysmal atrial fibrillation (AF), with favorable long-term outcomes. However, CA for persistent AF has not been well established. Moreover, the treatment of persistent AF frequently requires a more complicated strategy targeting not only the triggers but also the perpetuators of AF. Therefore, multiple procedures, such as complex atrial fractionated electrograms, rotor ablation, linear ablation, or substrate modification, in addition to pulmonary vein (PV) isolation, are performed for these patients.[1–7] In this case, we describe our experience in using left atrial inferior wall (LAIW) isolation for the treatment of long-standing persistent AF.

Case report

The patient was a 77-year-old woman with a 2-year history of long-standing persistent AF. Owing to an allergy to bepridil, AF was managed using cibenzoline. As her AF had become drug resistant, she was referred to us for CA. At the first session, we performed PV and left atrial (LA) posterior wall isolation, via combined cryoballoon and radiofrequency (RF) CA. After both PV and LA posterior wall isolation, spontaneous atrial tachycardia (AT) occurred, in which the origin was the mid-portion of the coronary sinus (CS). RF ablation of this area terminated the AT. However, AF recurred 1 day after the procedure and persisted despite the administration of pilsicainide, verapamil, and bisoprolol. Since the patient's AF was resistant to medication and electrical cardioversion, we planned a second intervention 2 months after the first.

KEYWORDS Atrial fibrillation; Catheter ablation; Coronary sinus; Left atrial inferior wall; Simultaneous isolation
(Heart Rhythm Case Reports 2020;6:702–705)

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors have no conflicts to disclose. **Address reprint requests and correspondence:** Dr Rena Nakamura, Heart Center, Japan Red Cross Yokohama City Bay Hospital, 3-21-1 Shinyamashita, Naka-ku, Yokohama, Kanagawa 231-0801, Japan. E-mail address: n.rena07@gmail.com.

KEY TEACHING POINTS

- Catheter ablation for long-standing persistent atrial fibrillation (AF) is sometimes challenging. In this case, after the isolation of pulmonary veins and the left atrial posterior wall and mitral isthmus ablation, abnormal electrograms like complex fractionated atrial electrogram were not observed; however, potentials inside the left atrial inferior wall (LAIW) showed clearly shorter cycle length compared to other areas during AF.
- We decided to isolate the LAIW, not eliminating these electrograms by point-by-point ablation. During the process of the isolation, even though AF was sustained inside the LAIW and coronary sinus (CS), other areas converted to atrial tachycardia and finally, sinus rhythm. For the confirmation of bidirectional block of the isolated high-frequency zone, pacing maneuvers by different cycle lengths were useful.
- If electrograms in the focal area exhibit shorter cycle length, even not abnormal ones, compared to other areas, the extensive isolation of this part may be beneficial for the maintenance of sinus rhythm. The isolation of only LAIW is not easy; thus the simultaneous isolation of both the LAIW and the CS is very helpful, which may also eliminate AF triggers of the CS.

We confirmed the recurrence of both roof and bottom block lines along the LA posterior wall, located just above the esophagus. Following RF application to these sites, the LA posterior wall was completely reisolated. In addition, we created a mitral isthmus block line to prevent perimetral AT under sinus rhythm. Following this, AF was easily induced by burst pacing of the CS. During AF, a circular

https://doi.org/10.1016/j.hrcr.2020.06.025

catheter placed in the LAIW revealed fractionated electrograms, exhibiting the shortest tachycardia cycle length compared to other sites, such as the right atrial or LA anterior wall or CS (Figure 1A, B). Abnormal electrograms were recorded over a broad area of the LAIW, and not from a focal point. Accordingly, we attempted to isolate the LAIW. As mentioned above, LA posterior wall isolation and a mitral isthmus block line had been already constructed and therefore, we proceeded with performing linear ablation from the bottom site of the right inferior pulmonary vein to the inferior mitral annulus, which was opposite to the CS (Figure 1C). During RF ablation at the inferior site of the mitral annulus in the left atrium (LA), AF was converted to AT, with a 607 ms tachycardia cycle length in the right atrium (RA), the left atrial anterior wall (LAAW), and the LA appendage, while AF was sustained in the LAIW and the CS (Figure 1D). At the next RF application, AT in the RA and the LAAW was terminated and turned to be sinus rhythm and sinus P wave was apparent by 12-lead electrocardiogram, while AF in the LAIW and the CS was gradually organized to local AT, with a short coupling interval of 235 ms (Figure 1E). Therefore, we mapped these localized areas, and identified a macroreentrant AT, rotating between the LAIW and the CS, which was terminated by linear ablation at the mid-portion of the LAIW. After local AT termination, both atriums completely converted to a sinus rhythm. However, the LAIW and CS were connected to the RA and the LAAW in true sinus rhythm, indicative of an incomplete LAIW isolation. Specially, under high right atrial burst pacing between 450 ms and 600 ms, a 1-to-1 conduction to the LAIW and the CS was identified, while under pacing at 400 ms, a 2-to-1 conduction was observed (Figure 2A). On the other hand, the pacing from the LAIW at 600 ms exhibited a 1-to-1 conduction to the high RA and the

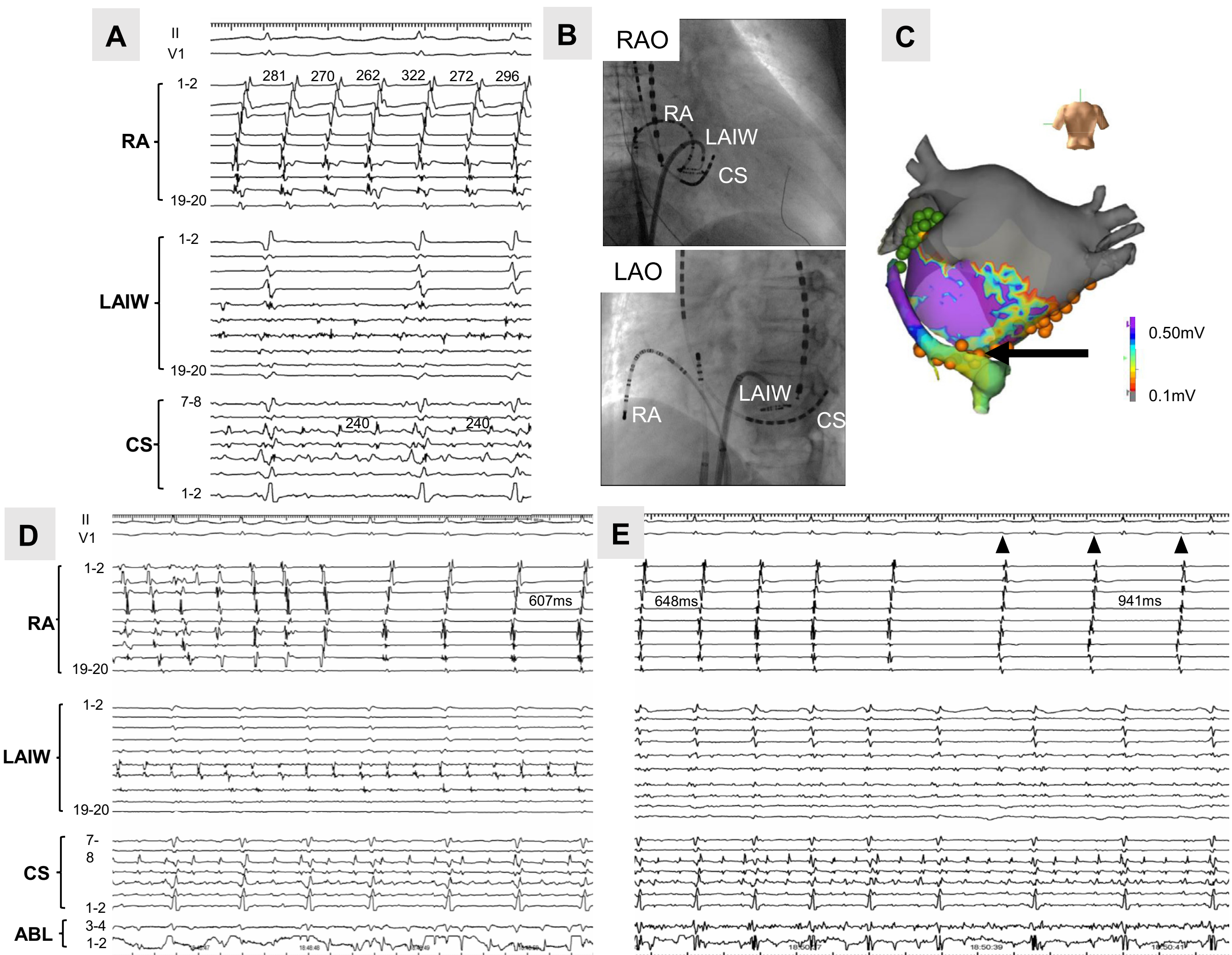

Figure 1 **A:** Shorter coupling and fractionated potential during atrial fibrillation (AF) observed in the left atrial inferior wall (LAIW). **B:** Catheters were placed in the right atrium (RA), left inferior wall, and coronary sinus (CS). **C:** The orange tags show the linear ablation performed from the bottom of the right inferior pulmonary vein to the mitral annulus, with the green tags showing the mitral isthmus block line. The black arrow shows the conversion of atrial fibrillation (AF) to atrial tachycardia (AT) in the RA at the inferior site of the mitral annulus. **D:** Tachycardia cycle length was prolonged and AF was changed to AT in the RA. **E:** Change of the AT to a sinus rhythm in the RA, but with sustained AT in the LAIW and CS; the black arrowhead shows the P wave of sinus rhythm. ABL = ablation catheter.

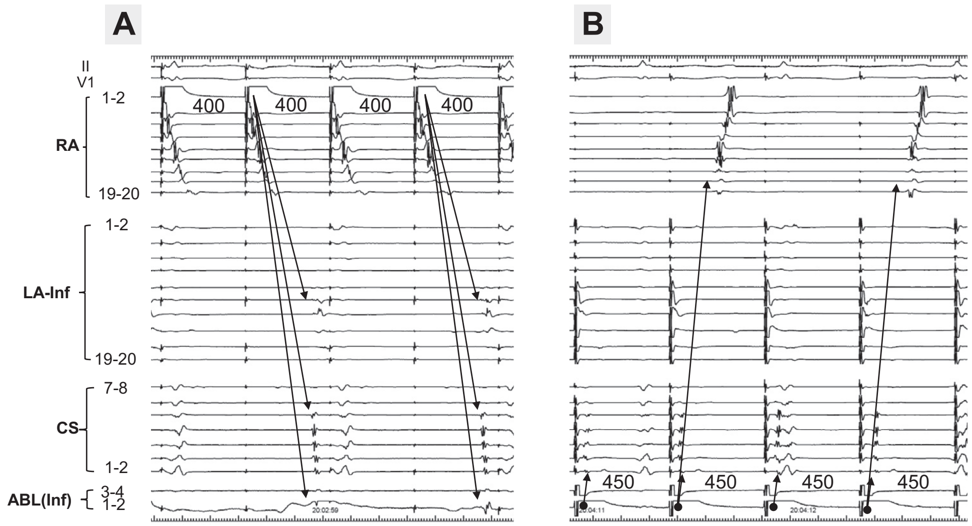

Figure 2 **A:** Right atrium (RA) burst pacing at 400 ms transmitted to the left atrial inferior wall (LAIW) and the coronary sinus (CS) via a 2-to-1 conduction pattern. **B:** LAIW burst pacing at 450 ms conducted to the RA, via a 2-to-1 pattern, and to the CS, via a 1-to-1 conduction pattern. The ablation catheter was located at the LAIW. ABL= ablation catheter.

LAAW, with a 2-to-1 conduction at a pacing of 450 ms (Figure 2B). This rate-dependent connection was observed, bidirectionally, between the LAIW and the RA plus the LAAW. We proceeded with RF application inside the body of the CS and the septum of the RA in order to isolate the LAIW; however, this approach failed. Consequently, we proceeded with ablation of the ostium of the CS to isolate the CS. During the ablation of the bottom area of the CS ostium after the entire circumferential applications, the CS was successfully isolated. Surprisingly, the LAIW was isolated simultaneously (Figure 3A, C, D). Dissociated potentials from the LAIW were identified, but these captured only the CS and did not conduct to the RA or LAAW (Figure 3B). We confirmed a bidirectional conduction block between the RA plus the LAAW and the LAIW plus CS. After that, any AT or AF became noninducible.

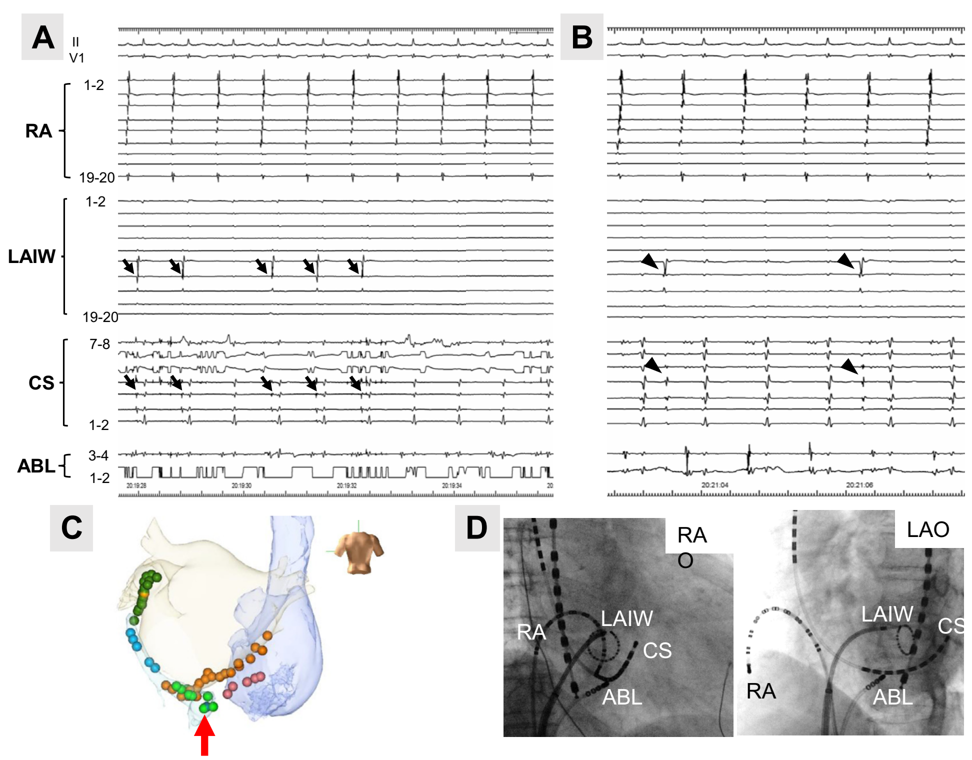

Figure 3 **A:** The left atrial inferior wall (LAIW) and the coronary sinus (CS) were isolated simultaneously (*black arrow*). **B:** Dissociated potentials were observed from the LAIW, which captured only the CS (*black arrowhead*). **C, D:** Radiofrequency application at the bottom of the CS resulting in isolation of the CS and LAIW (*red arrow*). ABL = ablation catheter; RA = right atrium.

The patient remained free from AT or AF over 15 months follow-up. The echocardiogram performed at 3 months after the second ablation revealed normal LA contraction (A wave 0.88 m/s).

Discussion

To our knowledge, this is the first case report regarding the usefulness of LAIW isolation for the treatment of long-standing AF. AF is not a simple arrhythmia, and CA for AF becomes much more complicated for persistent and long-standing AF, which is related not only to focal triggers but also to atrial substrate and modulators.[8] Therefore, the ablation strategy for these patients is not fully constructed, being dependent on patient characteristics and a surgeon's experience. Isolation of the LA posterior wall provides an additional treatment option to PV isolation, considering the large potential for AF triggers and substrates located in this area.[9] In our case, AF was still easily inducible and sustained even after PV isolation, LA posterior isolation, and mitral isthmus ablation. Careful examination of the electrograms indicated that the cycle length during AF was shorter in the LA than in the RA or the LAAW, and more especially in the LAIW. Hence, we considered the LAIW to be 1 of the responsible regions for AF substrate. In fact, the LAIW and CS were reported to be some of the most frequent AF drivers.[10] However, the areas related to AF were not pinpoint regions and as such, it was mostly impossible to locate the exact AF substrate. Therefore, we attempted to isolate the whole LAIW. Rhythm conversion from AF to AT and then sinus rhythm in the RA and LAAW was thought to be mostly achieved by isolation of the LAIW during RF applications at the posterior mitral annulus. However, complete LAIW isolation alone was difficult to achieve because of dense connections between the LA and the CS musculature.[11] Owing to these connections, it was hard to eliminate all CS-atrial junctions and to separate the LAIW from the CS electrically. Thus, we first isolated the CS itself, achieved by RF application at the bottom of the CS ostium. Interestingly, isolation of the CS accomplished isolation of the LAIW at the same time. Our experience shows that although LAIW isolation, especially from the CS musculature, was quite difficult to achieve, composite isolation of the LAIW and CS was much easier to attain. On the other hand, the CS itself is 1 of the major nonpulmonary vein foci of AF and, thus, CS isolation contributes to the elimination of triggers from the CS musculature.[12,13] Of particular note was the effectiveness of LAIW isolation in converting both atriums, to AT and then a sinus rhythm, except the LAIW and the CS, despite the persistence of AT/AF in the LAIW. This fact proved that the LAIW was the dominant substrate for AF in this patient, as we had expected. Although LAIW isolation in addition to LA posterior wall may have a negative effect on atrial function, the echocardiography after ablation showed an almost normal atrial contraction pattern.

For patients who exhibit higher-frequency potentials during AF in the LAIW compared to that in other areas, isolation of LAIW may be effective for maintaining sinus rhythm, rather than performing pinpoint ablations for these electrograms.

Conclusion

We report a first case of LAIW isolation in combination with PV and LA posterior isolation as treatment for long-standing AF, which was effective in re-establishing and maintaining a normal sinus rhythm. Spatial, sequential, frequency gradient–dependent ablation may be useful as an adjunct in some cases of long-standing persistent ablation with confirmation of bidirectional block by pacing maneuvers of the isolated high-frequency zones. Performing simultaneous LAIW and CS isolation could make it easier to isolate the LAIW and therefore be a very useful method for the treatment of persistent AF.

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