Subclinical persistent atrial fibrillation in left atrium behind the ectopic atrial rhythm on electrocardiogram

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Introduction

Surface electrocardiogram (ECG) represents the activation of the right and left atrium (LA). We report on persistent atrial fibrillation (AF) maintained in an electrically isolated LA with an electrocardiogram showing ectopic atrial rhythm. This report implies the potential risk of stroke of unknown causes without manifestations of AF on electrocardiography.

Case report

A 74-year-old man presenting with intermittent palpitations was referred to our hospital. An ECG showed paroxysmal atrial flutter (AFL) consistent with palpitations, while the basic rhythm of the patient had an ectopic atrial rhythm (Figure 1). The patient showed no signs of heart failure. Owing to the occasional occurrence of intolerable palpitations of AFL, the patient was scheduled for catheter ablation after providing informed consent. The patient had a history of chronic kidney disease and hypertension. The patient had also undergone on-pump mitral valve replacement (Carpentier-Edwards Perimount pericardial valve), tricuspid annuloplasty, surgical closure of the left atrial appendage (LAA), and surgical pulmonary vein isolation (PVI) by cryoablation 13 years prior, owing to severe mitral regurgitation and AF, which was initially diagnosed approximately 20 years ago. Cryoablation was also performed on the right atrial (RA) isthmus. Surgery was performed via a RA incision and right-sided LA incisions for mitral valve replacement and tricuspid annuloplasty. No other ablation or surgical maze procedure was performed on the LA body. The patient had no previous history of cardiac transplantation. Thereafter, the patient had a good course without AF recurrence on a 12-lead surface ECG during follow-up with medications, including anticoagulation therapy with warfarin, beta-blocker, diuretics, and angiotensin II receptor blocker. Preoperative echocardiography demonstrated an enlarged LA with an LA volume of 146 mL and volume index of 94 mL/m^2. Plane computed tomography revealed a dilated LA chamber with severe remodeling and no obvious pulmonary vein stenosis.

At the beginning of catheter ablation, 12-lead surface ECG demonstrated a regular ectopic atrial rhythm of 75 beats per minute. Under the ectopic atrial rhythm, electroanatomical mapping of the LA was performed after transseptal puncture using a high-density mapping catheter (OCTARAY™; Biosense Webster, Inc, Irvine, CA) to evaluate the electrical gap in the pulmonary vein. A bipolar voltage map of the LA was generated, and most LA areas were covered by low-voltage areas (Figure 2A). Interestingly, the anterior septum region of the LA was in an ectopic atrial rhythm; however, the remaining LA, including the roof, posterior, and lateral walls, maintained an AF rhythm (Figure 3). In addition, a conduction block line was observed at the boundary zone of the anterior side of the LA between the ectopic atrial rhythm and AF areas, encircling the anterior region in the LA (Figure 2B). Part of the conduction block line was consistent with that of the previous surgical incision. In contrast, the RA involved a large

KEY TEACHING POINTS

- A rare feature of persistent atrial fibrillation (AF) in the left atrial (LA) region, which is completely masked on the surface electrocardiogram (ECG), may imply the risk of subclinical stroke as an unknown cause.
- A large, dilated LA with severe remodeling and surgical ablation for AF might be associated with an unexpected block line and isolated AF rhythm in a limited area.
- The masked AF on ECG might be due to advanced AF with low amplitude and surgical retraction of the LA appendage.

KEYWORDS Atrial fibrillation; Atrial flutter; Ectopic atrial rhythm; Left atrium; Surgery

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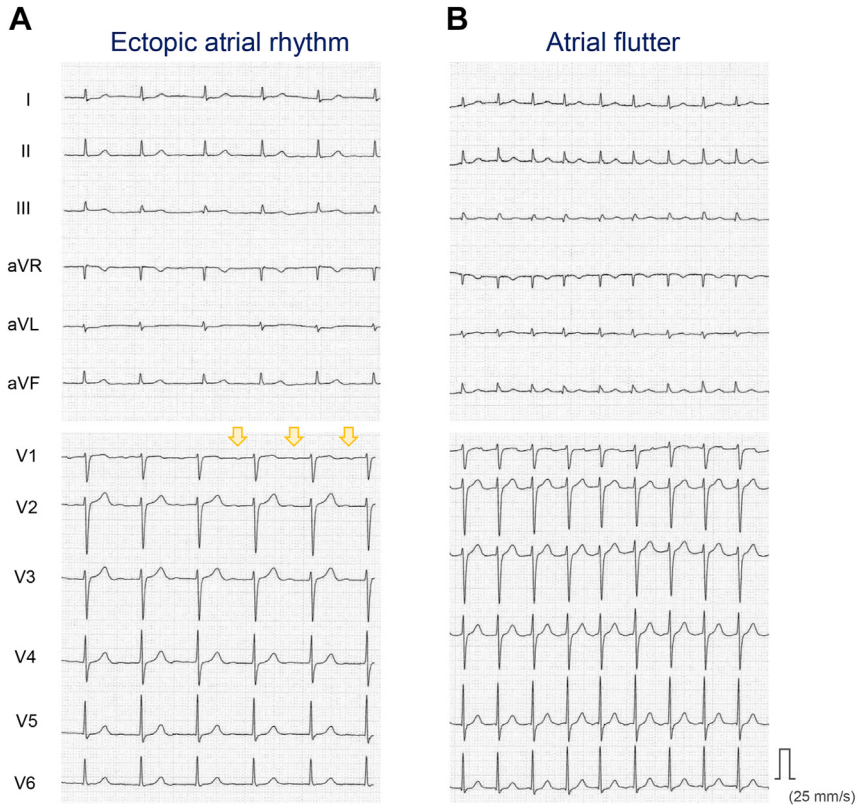

Figure 1 A 12-lead surface electrocardiogram. **A:** Ectopic atrial rhythm. **B:** Atrial flutter. The yellow arrows indicate P waves.

low-voltage area, except for the anterior wall and septum (Supplemental Figure 1A). RA was dominated by an ectopic rhythm with no AF rhythm. The ectopic atrial rhythm originated from the area surrounding the U-shaped block line in the anterior wall of the RA, and propagated to the septum and part of the anterior wall of the LA (Supplemental Figure 1B). In contrast, stimulus pacing from the LA with an ectopic rhythm area confirmed electrical conduction

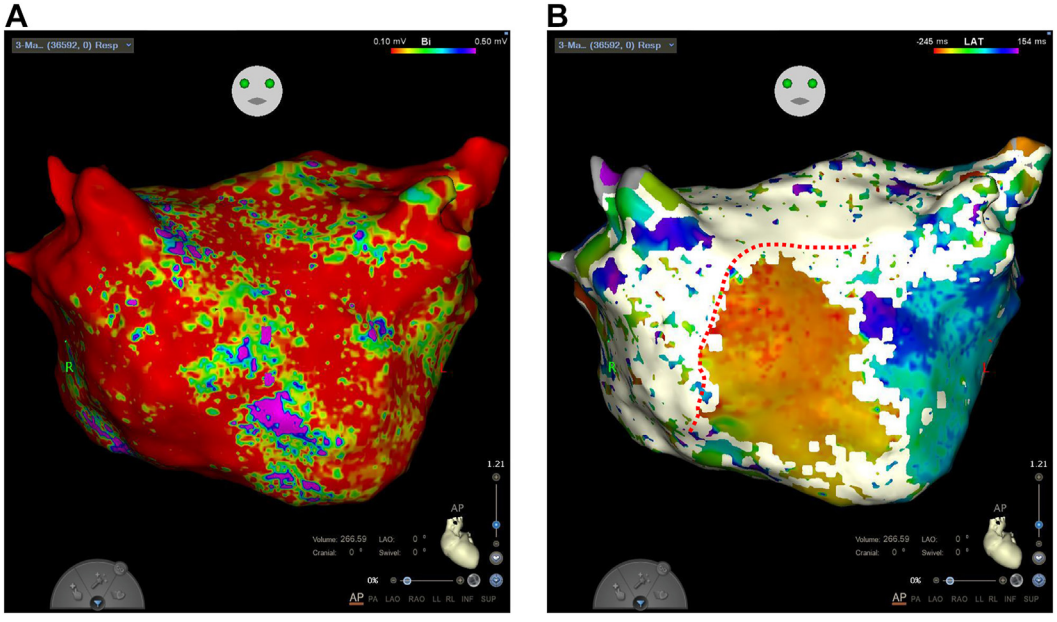

Figure 2 Electroanatomical maps for the left atrium during ectopic atrial rhythm on 12-lead electrocardiogram (ECG). **A:** Bipolar voltage map of the left atrium in the anteroposterior view. The low bipolar voltage area was defined as <0.50 mV. **B:** Local activation time map of the left atrium in the anteroposterior view. The lower range of the early meets, late meets equipped with the mapping module, was set to 20%. The red dotted line indicates previous surgical incision. The QRS wave on the surface ECG was used as the reference during activation mapping.

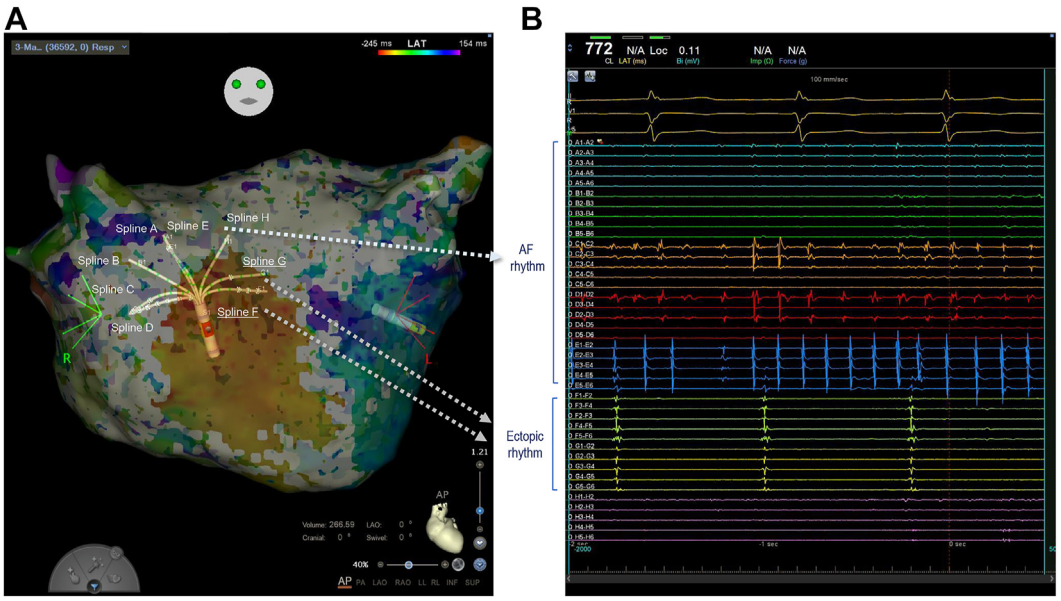

Figure 3 Mixed feature of ectopic atrial rhythm and atrial fibrillation (AF) in left atrium. **A:** Anterior view. OCTARAY (Biosense Webster, Inc, Irvine, CA) placed in the border region between the ectopic atrial rhythm and the AF rhythm in the left atrium. The QRS wave on the surface electrocardiogram (ECG) was used as the reference during activation mapping. **B:** Intracardiac electrogram on OCTARAY. The body surface ECG and electrode splines F and G showed an ectopic atrial rhythm, whereas the other electrodes demonstrated an AF rhythm.

from the LA to the RA and orthodromic atrioventricular conduction to the ventricle (Supplemental Figure 2).

After high-density mapping and electrophysiological studies, cardioversion was repeatedly attempted to terminate the AF that was maintained in the local LA area. However, this procedure was unsuccessful. Considering the large low-voltage area covering the entire LA and only tiny potentials remaining in the LA body, it was difficult to determine the electrical gap of the pulmonary vein. Thus, PVI and additional linear ablations for the AF area were not performed in this case. Importantly, the LAA should be extracted beforehand. Subsequently, atrial burst pacing induced clinical AFL, which was diagnosed using activation mapping, representing macroreentrant tachycardia encircling the scar on the lateral RA wall (Supplemental Figure 3). Given the careful assessment of the conduction block line surrounding the origin of the ectopic beat that was close to the lateral scar and the safety of securing the activation route from the origin of the ectopic rhythm to the atrioventricular node, subsequent radiofrequency ablation of the lateral side for the tachycardia isthmus successfully terminated the AFL (Supplemental Figure 3). An ectopic atrial rhythm was observed after the AFL termination by ablation. The procedure was completed after noting the absence of any evidence of induction of AFL or AF in the RA and part of the LA by repetitive pacing stimulations with isoproterenol loading. The procedure was completed without complications.

At the follow-up of 6 months after ablation, the patient had no recurrence of AF or AFL on 12-lead or Holter ECG. Anticoagulants were continued because of the possibility of persistent AF in the limited LA; however, no neurological dysfunction or stroke events occurred thereafter.

This study was approved by the institutional review board in Yokkaichi Municipal Hospital (2023-6).

Discussion

In the present case, despite the body surface ECG and procedural mapping demonstrating an ectopic atrial rhythm in the RA and part of the LA, the majority of the LA showed an AF rhythm. This may be due to a conduction block line encircling the anterior LA, which may have emerged owing to previous surgical interventions and advanced LA remodeling. It is extremely rare to observe a block line that completely encircles the LA anterior wall and isolates conduction from other LA bodies, masking the presence of AF in the resting LA area. This electrical discrepancy during catheter ablation as another indication for AFL was an interesting and accidental finding.

Several explanations may be considered for the distinct feature of the absence of an f-wave in the body surface ECG, despite the AF rhythm on the intracardiac electrograms of the LA seen in the present case. The extensive myocardial damage with severe remodeling, as demonstrated by the large low-voltage area and enlarged LA chamber of most of the LA, may result in atrial arrest with decreased amplitude and activity. The amplitude of the f-wave on the ECG also decreased after the long burden of persistent AF.[1] Nonetheless, high-density mapping using a high-resolution mapping catheter with a short electrode distance could enable the recognition of tiny potentials with low amplitude on the AF rhythm in the LA. In addition, the morphology of P-waves on ECG generally consists of activation of the atrial septum and LAA contraction; thus, the absence of the LAA after surgery may make f-waves difficult to recognize.

The coexistence of different rhythms in the heart was reported in cases with a history of cardiac transplantation[2]; however, our case had no previous history of cardiac transplantation. Possibly, this rare phenomenon may have occurred owing to a severely damaged atrium and conduction block in this case.

Latent cerebral infarction may occur despite the absence of AF on ECG monitoring,[3] most likely owing to a lack of continuous assessment for the detection of AF. However, another possible cause is masked AF occurring behind the isolated region. We propose that masked AF, such as the one seen in the present case, may have a hidden risk of cryptogenic cerebral infarction, although surface ECG examination showed no obvious signs of AF. The risk increases when anticoagulant drugs are discontinued based only on the assessment of the surface ECG in such cases. From another perspective, more aggressive efforts, including PVI and additional ablations, might have been suggested to achieve AF termination in the LA, where AF drivers may exist to reduce the risk of stroke.[4,5] However, such ablations were expected to be difficult because of the extensive low-voltage areas in the dilated LA, where only tiny, low potentials could be recognized while searching for a gap in conduction. Furthermore, because the patient had a long history of AF duration and unsuccessful termination by cardioversion,[6] the recurrence rate of AF after catheter ablation was expected to be high.[7] We cannot judge the exact rhythm, particularly in the isolated LA area, only through a body surface ECG during the follow-up in an outpatient clinic, even if the AF in the LA is successfully terminated and maintained after the ablation; therefore, the assessment of recurrence and effect of treatment cannot be confirmed.

In this case, the LAA was surgically closed, which is thought to have reduced the risk of cerebral infarction to some extent. However, a thrombus can also arise in the LA body outside the LAA.[8,9] In such cases, continuation of anticoagulant therapy may be recommended.

Conclusion

The unexpected formation of a block line encircled in the LA may have resulted in the maintenance of AF only in the LA, although the body surface ECG did not show an AF f-wave.

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Appendix

Supplementary Data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2023.07.005

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