

Focal atrial tachycardia originating from mirror position of fossa ovalis: A case report



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Introduction

In patients undergoing ablation of focal atrial tachycardia (FAT) arising from the interatrial septum (IAS), mapping of both atria is required. Electroanatomical mapping of the IAS and identification of earliest activation are necessary for assessing arrhythmia origin, leading to an effective radiofrequency ablation. The fossa ovalis (FOv) is an anatomical structure of the right atrium (RA). However, FAT may also arise from the corresponding left IAS. The present case is a FAT originating from the left IAS mirror position of the FOv, corresponding to the earliest activation of the RA. The earliest RA electrogram with double potentials identified in the area of the FOv predicts the mirror position within the left atrium.

Case reports

A 26-year-old female patient was referred to our center for catheter ablation of recurrent drug-resistant sustained atrial tachycardia (AT). No additional cardiovascular risk factors or history of previous heart surgery were present. Transesophageal echocardiography at admission demonstrated normal cardiac structure and excluded patent foramen ovale. The 12-lead surface electrocardiogram (ECG) indicated a sustained AT with 1:1 AV conduction, and a positive P wave in lead V₁ and negative in lead II, III, and aVF, predicting a possible left atrial (LA) origin (Figure 1A). During an electrophysiological study, a standard decapolar catheter was placed in the coronary sinus (CS) as the reference electrode. The endocardial recording showed an AT with a tachycardia cycle length of 500 ms, with a concentric CS activation sequence (CS 9/10: proximal CS) (Figure 1B).

In the beginning, we attempted entrainment pacing at proximal CS and distal CS, respectively, to differentiate

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KEY TEACHING POINTS

- The interatrial septum (IAS) is a small region of the fossa ovalis (FOv) with its rim and adjacent atrial walls from both sides.
- The present case is a focal atrial tachycardia (FAT) originating from the mirroring location of FOv in the left IAS. The earliest activation of the right atrium recorded in the FOv exhibited a double potential, consisting of an early far-field deflection and a subsequent near-field deflection. The timing of the earlier far-field deflection in the FOv was equal to that of the earliest near-field deflection in left atrial mapping, which was recorded at the mirror position of the FOv from the left IAS.
- In combination with 3-dimensional mapping, the signal pattern of the earliest local activation is important to distinguish between near-field and far-field deflections to optimize the ablation strategy.

left or right atrial origin according to the response. The entrainment pacing was unsuccessful and sustained atrial fibrillation was induced. Subsequently, electrical cardioversion was done to achieve sinus rhythm. But the clinical AT recurred spontaneously shortly after the cardioversion. Therefore, 3-dimensional electroanatomic mapping during AT was performed to determine the activation sequence and mechanism of the arrhythmia.

Transseptal puncture was completed by using a Brockenbrough (BRK XS) transseptal needle via a long steerable sheath (Agilis medium curve; Abbott, Chicago, IL). Activation mapping was performed during AT using the CARTO3 system (Biosense Webster, Diamond Bar, CA). A multipolar high-resolution mapping catheter (PentaRay, Biosense Webster) and a 3.5-mm-tip SmartTouch ThermoCool (Biosense Webster) ablation catheter were subsequently placed in both atria for high-density mapping of the area of interest. The CS electrogram was used as a reference during mapping.

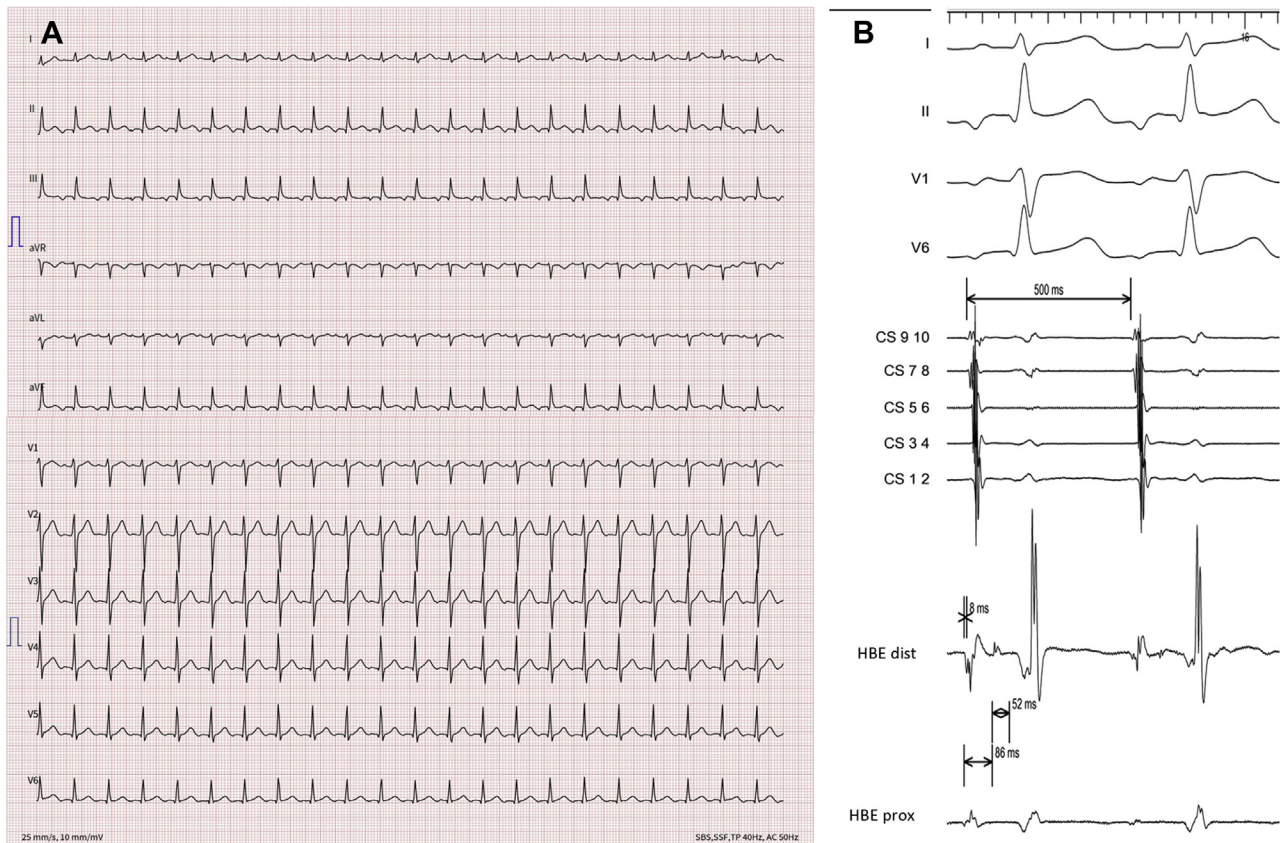


Figure 1 **A:** Surface 12-lead electrocardiogram (ECG) of the atrial tachycardia (AT) (paper speed 25 mm/s). **B:** Surface ECG leads I, II, V₁, and V₆ and endocardial recordings during AT (recording speed 100 mm/s). CS = decapolar catheter (CS 1-10) in the coronary sinus; HBE = quadripolar electrode placed at the His bundle site, recording an HV interval of 50 ms during AT. Of note, the atrial signal on HBE was 8 ms earlier than proximal CS (CS 9/10).

RA mapping showed the earliest activation at the FOv, 20 ms early from P' onset. Whereas the local electrogram was actually characterized by a double potential consisting of a far-field signal of the left and near-field of the right-sided septum (Figure 2A). The FOv showed tenting by the ablation catheter with a force of 40 g during mapping (Figure 2B). Meanwhile, LA mapping showed the earliest activation with the identical timing (near-field potential with 20 ms early from onset of P' wave during AT) at the mirror position of the FOv (Figure 2D).

When mapping the AT in both atria, the bipolar endocardial map confirmed normal voltage beside fragmented potentials near the FOv, identified as the rim (pink points on CARTO images). Activation mapping revealed that activation propagated focally from the mirror position of the FOv in the left IAS, serving as the origin (Figure 3B). A continuous radiofrequency ablation with a power of 30 W, temperature limit of 43°C, and irrigation rate of 17 mL/min at the focus was applied. AT readily terminated and converted into sinus rhythm during ablation (Figure 3A). Another 3 minutes' ablation at the area of the focus was performed. No more AT was inducible at the end of the procedure.

Discussion

Medical therapy is usually ineffective in patients with FAT, and catheter ablation is an effective and safe therapy targeting the focus of the tachycardia.¹ In patients without structural heart disease or prior heart surgery, left FAT tends to originate from specific atrial structures, among which the left aspect of the IAS is less common.²⁻⁴ FAT arising from the left IAS has been defined as of superior septum, mid septum, or inferior septum origin in literature.⁵ Owing to the complex anatomy from embryological development, the IAS is a small area of the FOv with the rim and the adjacent atrial wall from both sides.⁶ Some studies demonstrate that the actual interatrial structure of the IAS is the FOV with its rim.⁷ Although there are 2 reported cases of FAT arising from the FOv,^{8,9} the left septal origin of FAT focusing on the FOv has no written literature. The present case firstly reported a FAT arising from the LA mirroring position of the FOv.

When the FAT focus is close to the IAS, surface ECG and endocardial activation are both challenging to differentiate between RA and LA origin owing to the variable ECG morphology and endocardial activation timing.⁵ A 15 ± 5 ms local activation, recorded at the His bundle region, ahead

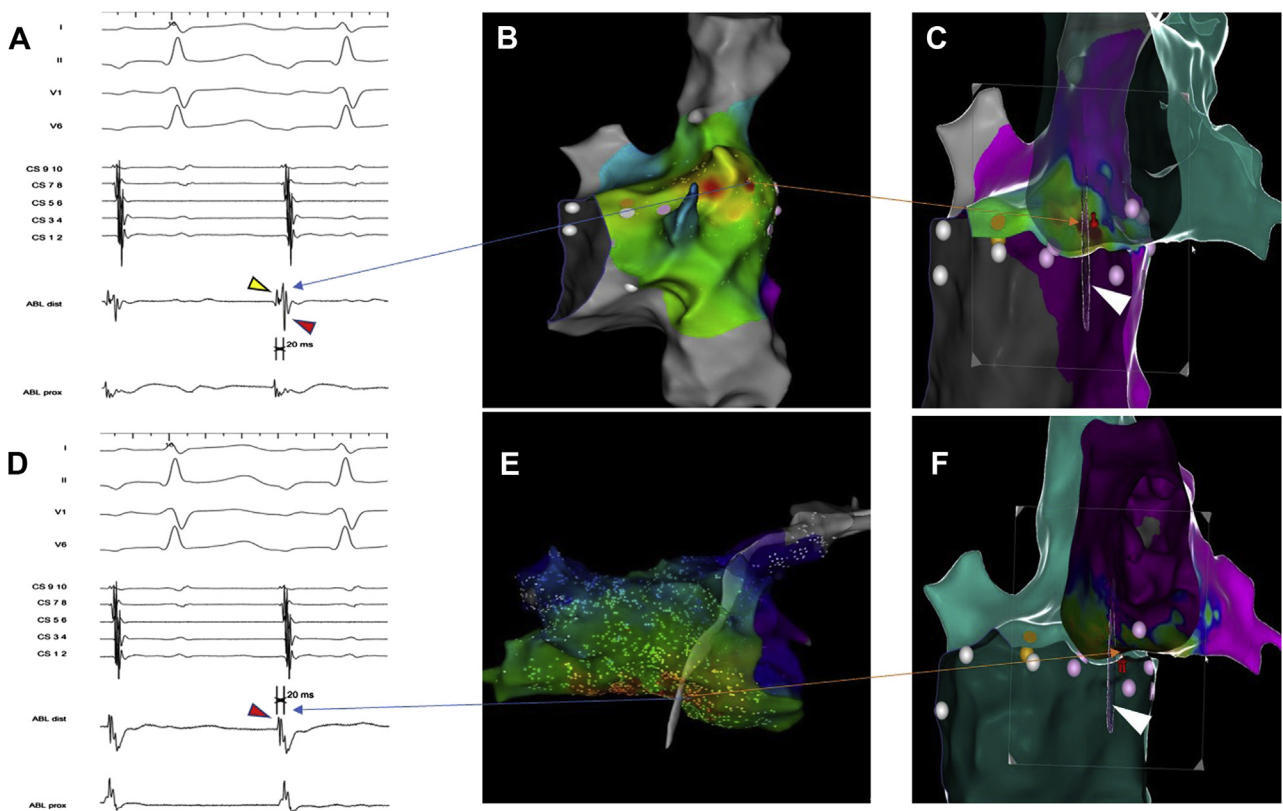


Figure 2 Activation mapping of the right atrium (RA) (A–C) and left atrium (LA) (D–F) during atrial tachycardia (AT). **A:** Electrogram (EGM) recorded at the site of the earliest activation at the fossa ovalis (FOv) with a far-field component (yellow arrowhead) preceding the near-field one (red arrowhead). Paper speed 100 mm/s. **B:** Activation mapping of RA during AT, with the earliest activation at FOv with double potentials (blue arrow line). The image projection was a modified left lateral view. **C:** Modified CARTO view (CARTO3 system; Biosense Webster, Diamond Bar, CA) of earliest activation (red) at the FOv, shown on the right side in contrast with the left interatrial septum (IAS); transseptal puncture was anatomically mapped, marked with a white arrowhead. **D:** EGM showing the earliest activation of the LA at mirror site of the FOv with near-field potential (red arrowhead) followed by a far-field potential. Of note, the timing of the earliest activation on both sides was identical. **E:** Activation mapping of LA during AT, showing the earliest activation at the mirroring site of right-sided local activation times map (blue arrow line). The image projection was a modified right anterior oblique CARTO view. **F:** Modified CARTO view of earliest activation (red pin) in LA at mirror position of FOv, shown on the left side in contrast with the right IAS.

of surface P wave is reported to speak for FATs arising from the left IAS.¹⁰ This recorded activation could also originate from other LA structures, such as the mitral annulus.⁴ Therefore, biatrial septal mapping is necessary for these patients to identify the chamber of origin.

During RA and LA mapping, the earliest activation in the RA was recorded at the FOv, proved by tenting of the IAS by the ablation catheter. The local double potentials consist of a blunt and more minor first component and a sharp and more significant second component. The timing of the minor component equals the timing of the earliest LA activation recorded at the mirror position of FOv from the left IAS.¹¹ In combination with 3-dimensional mapping, we analyzed the morphology of the earliest endocardial activation in both atria and differentiated near-field/far-field components at the mirror position of the IAS. Fortunately, the tachycardia was not terminated by repetitive IAS mapping and transseptal puncture procedure. Thus, we were able to complete a precise high-density electroanatomical map and identify the focus of the tachycardia at the left atrial mirror position of the FOv.

Concerning the mechanism of this focal AT, we prefer microreentry as the mechanism instead of triggered activity or enhanced automaticity. Firstly, high-resolution mapping showed a focal activation radiating from the left FOv with corresponding earliest activation. But the AT was insensitive to adenosine, which speaks for microreentry.¹² Secondly, this incessant AT could not be terminated with programmed stimulation, and there was no manifestation of tachycardia rate warm-up during initiation and cool-down during termination. None of the above support triggered activity or enhanced automaticity. However, the debate remains, since it is not possible to definitely confirm microreentry with currently applied high-resolution mapping techniques.

Conclusion

Endocardial atrial activation mapping of both atria is crucial to identify the focus of FAT arising from the IAS. Recording of an early double potential at the FOv may point to a left-sided origin from the mirror position of the FOv and warrant successful ablation.

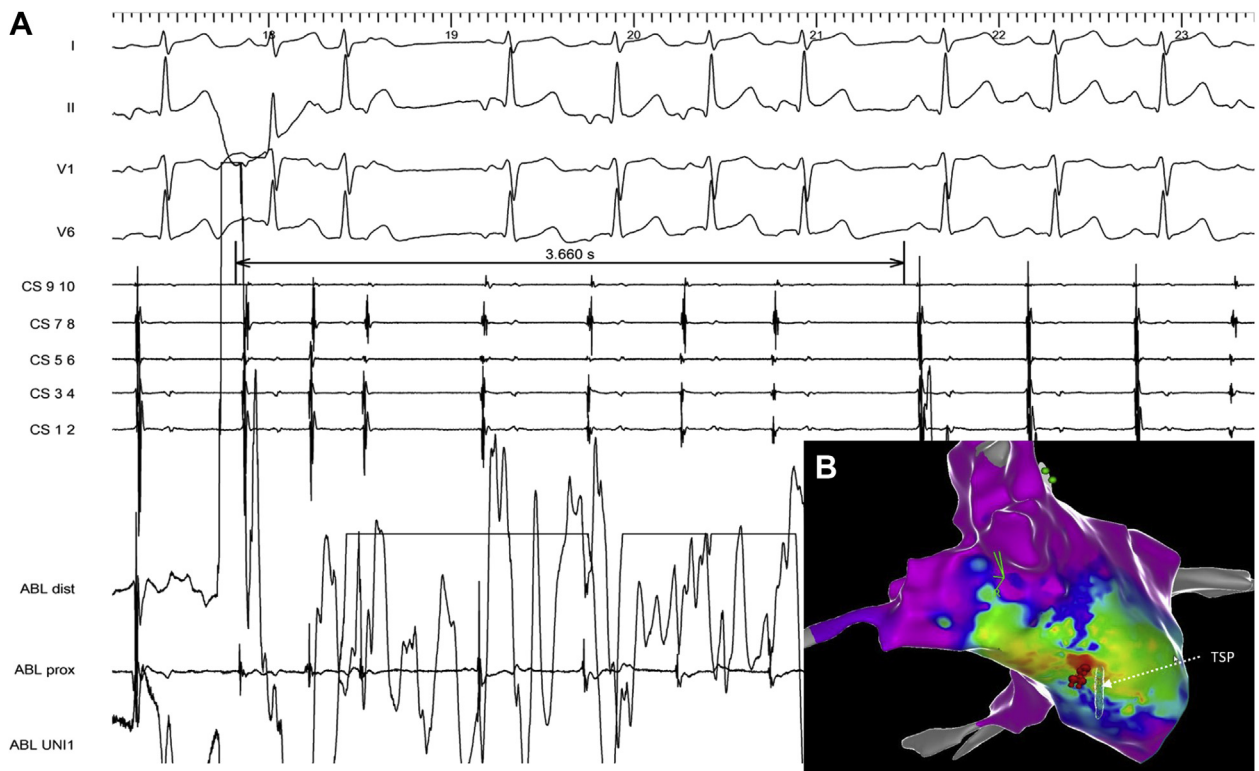


Figure 3 Endocardial recoding of successful ablation in the left interatrial septum at the mirror position of the fossa ovalis. **A:** Surface electrocardiogram and intracardiac electrogram recording of the termination of atrial tachycardia with ablation at the focus within 3.7 seconds. **B:** Electroanatomical map demonstrating the target adjacent to the transseptal puncture location (*white arrow*).

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