A rare case of adenosine-sensitive atrial tachycardia originating at the mitral annulus's anterior septum

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Introduction

Adenosine-sensitive atrial tachycardia (AT) is considered a mechanism of reentry. It is characterized by tachycardia termination or tachycardia cycle length (TCL) prolongation by small amounts of adenosine triphosphate.[1] Adenosine-sensitive AT usually originates near the atrioventricular (AV) node and tricuspid annulus,[2–5] and it can be safely and remotely eliminated at the entrance to the slow conduction zone (SCZ), as indicated by the manifest entrainment-guided strategy. In more detail, to study the fusion of atrial electrograms at the endocardial level during tachycardia, it is critical to ensure that the orthodromic tachycardia wavefront and the antidromic paced wavefront meet in the atrium after the orthodromic wavefront has passed through the SCZ. This requires that the paced wavefront can enter the reentry circuit at an anatomically distinct site from where it exits. In addition, successful demonstration of orthodromic capture at the earliest activation site (EAS) during manifest entrainment indicates the presence of an SCZ within the reentry circuit. This is located between the pacing site where manifest entrainment is evident and the EAS.[6]

There have also been rare reports of adenosine-sensitive AT originating from the left atrium.[7,8]

Herein, we present a rare case of adenosine-sensitive AT originating from the anterior septum of the mitral annulus. Because the EAS of the right atrium was orthodromically captured from the distal coronary sinus (CS) during tachycardia, it was suggested that the entry of the SCZ was located between the distal CS and the right atrial septum.

Hence, AT could be safely treated at the site away from the EAS.

KEY TEACHING POINTS

- Catheter ablation for atrial tachycardia originating near the His bundle should be performed with caution owing to the risk of atrioventricular block.
- When treating atrial tachycardia near the origin of the His bundle, it is essential to consider the results of entrainment and 3D mapping to identify the most suitable site (right atrium, noncoronary cusp, or left atrium) from which to ablate.
- The majority of atrial tachycardias originating near the His bundle are treatable from the right atrium or noncoronary cusp. However, there are rare cases of atrial tachycardias originating from the mitral annulus's anterior septum. It is important to recognize the orientation of the slow conduction zone by observing manifest entrainment between the distal coronary sinus and right atrial septum.

Case report

A 54-year-old woman with a history of stroke presented to the emergency department with frequent palpitations. The clinical examination and echocardiogram did not reveal any abnormalities. The electrocardiogram showed regular tachycardia with a heart rate of 160 beats/min, a short RP, and a narrow QRS (Figure 1A). The 12-lead electrocardiogram showed negative/positive biphasic P-wave morphologies during tachycardia in leads I, aVL, V_1, II, III, and aVF.

After the patient's written informed consent had been obtained, an electrophysiological study was conducted. Multielectrode catheters were placed via the right femoral vein at the high right atrium, His bundle region, and right ventricular apex. Additionally, a catheter was placed at the CS via the right jugular vein. The baseline Wenckebach rate was 150 beats/min, and no ventriculoatrial (VA) conduction was observed. Atrial extrastimuli consistently induced clinical tachycardia with a TCL of 400 ms, which was sustained with a Wenckebach-type atrio-hisian block (Figure 1B).

KEYWORDS Atrial tachycardia; Catheter ablation; Adenosine sensitive; Mitral annulus; Near the His bundle; Manifest entrainment; Cryoablation

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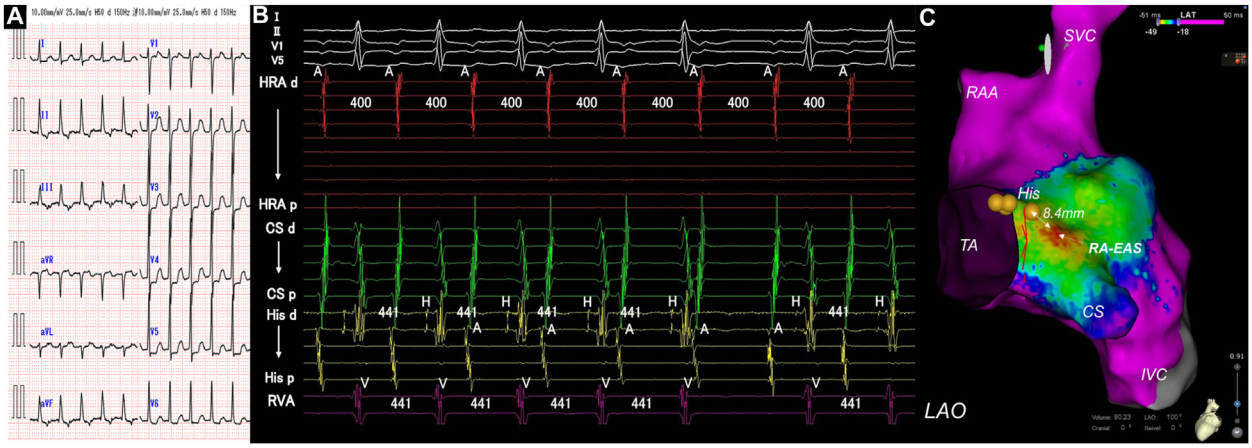

Figure 1 **A:** The 12-lead electrocardiogram revealed a regular tachycardia with a heart rate of 160 beats/min, narrow QRS, and short RP. The P-wave morphology was biphasic negative/positive in leads I, aVL, and V_1, as well as negative/positive in leads II, III, and aVF. **B:** The clinical tachycardia with a tachycardia cycle length of 400 ms, which was sustained with a Wenckebach-type atrio-hisian prolongation and block. **C:** During atrial tachycardia, activation map of the right atrium revealed a centrifugal pattern. The earliest activation site was located 8.4 mm posterior and inferior to the His bundle. CS = coronary sinus; CS d = coronary sinus distal; CS p = coronary sinus proximal; His = His bundle; His d = his bundle distal; His p = his bundle proximal; HRA d = high right atrium distal; HRA p = high right atrium proximal; IVC = inferior vena cava; LAO = left anterior oblique view; RAA = right atrial appendage; RA-EAS = right atrial earliest activation site; RVA = right ventricular apex; SVC = superior vena cava; TA = tricuspid annulus.

The earliest atrial activation was recorded by the His bundle electrode. VA dissociation was observed with overdrive pacing from the right ventricular apex. The VA interval after differential atrial overdrive pacing and last entrainment sequence were unmeasurable because of atrio-hisian prolongation and block.[9,10] During tachycardia, rapid intravenous administration of 3 mg of adenosine triphosphate prolonged the TCL and terminated tachycardia reproducibly without delay in AV conduction. Therefore, the patient was diagnosed to have adenosine-sensitive AT.

RA activation mapping was performed during tachycardia using a high-density multipolar electrode mapping catheter (OCTARAY; Biosense Webster, Diamond Bar, CA, USA). The EAS was the right atrial septum, 8.4-mm posteroinferior to the His bundle potential recording site (Figure 1C).

Overdrive pacing was performed from multiple locations in the right atrium during tachycardia, and the right atrial earliest activation site (RA-EAS) and His bundle potentials were recorded using a multielectrode catheter. RA-EAS was captured antidromically following pacing from the cavotricuspid isthmus, right atrial appendage, low lateral, high posteroseptal, and low posteroseptal regions of the right atrium and CS ostium (Figure 2A). The RA-EAS was captured orthodromically following overdrive pacing from the distal CS electrode near the mitral annulus at the 2 o'clock position (Figure 2B). This indicated that the SCZ of the tachycardia was located at the left atrium (Figure 3A). Thus, a transseptal puncture was performed. The left atrial (LA) activation map showed a centrifugal pattern and the EAS was located at the 9 o'clock position of the mitral annulus (Figure 3B). No obvious SCZ was detected on the 3D map. The left atrial earliest activation site (LA-EAS) preceded the RA-EAS by 14 ms. Cryoenergy was delivered via a catheter positioned 7 mm away from the LA-EAS during AT

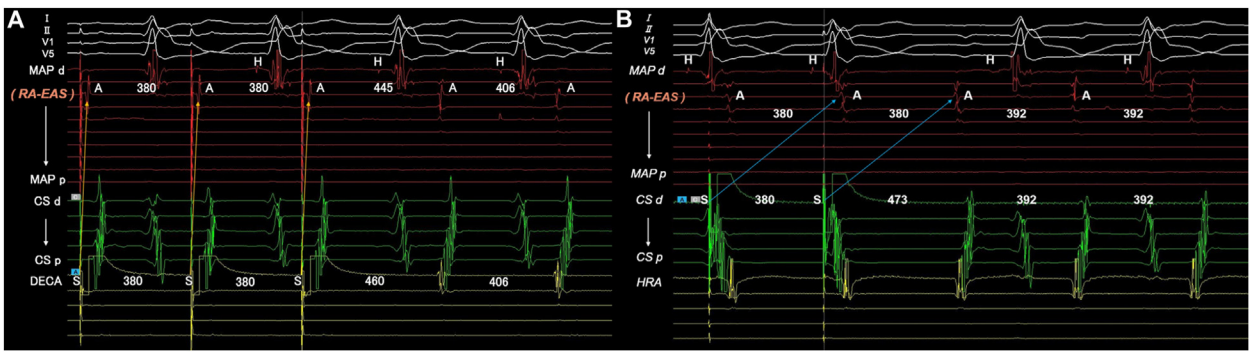

Figure 2 **A:** The values shown on the intracardiac electrocardiogram are atrial cycle lengths. During tachycardia, overdrive pacing was performed at 380 ms, an interval shorter than the tachycardia cycle. Right atrial earliest activation site (RA-EAS) was captured antidromically (*orange arrows*) with overdrive pacing from the high posteroseptal right atrium. **B:** RA-EAS was captured orthodromically (*light blue arrows*) with overdrive pacing from the coronary sinus distal electrode near the mitral annulus at 2 o'clock position. CS d = coronary sinus distal; CS p = coronary sinus proximal; DECA = DECANAV: mapping catheter; HRA = high right atrium; MAP d = mapping catheter distal; MAP p = mapping catheter proximal.

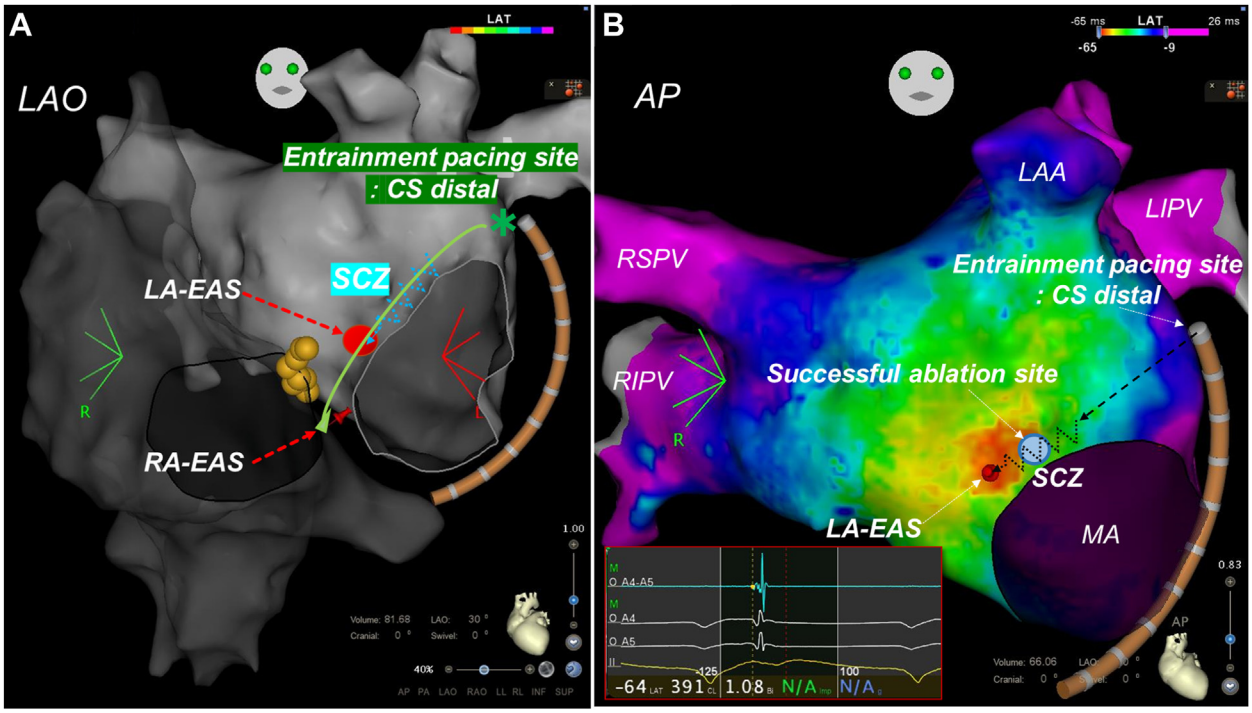

Figure 3 **A:** The slow conduction zone (SCZ) of the atrial tachycardia was present at the left atrium. The activation map of the left atrium revealed that the earliest activation site was at the 9 o'clock position of the mitral annulus (MA). **B:** Cryoablation was successfully performed at a site 7 mm away from the earliest activation site during atrial tachycardia in the direction of the distal electrode of the coronary sinus (CS). AP = anteroposterior view; LAA = left atrial appendage; LA-EAS = left atrial earliest activation site; LAO = left anterior oblique view; LIPV = left inferior pulmonary vein; RA-EAS = right atrial earliest activation site; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

toward the distal CS electrode (Figure 3B). Cryomapping was performed at -30°C, which successfully terminated AT. Thereafter, cryoablation was continued at -80°C for 240 seconds. The subsequent program stimulation did not induce any arrhythmias, and there was no recurrence of tachycardia over the 1-year observation period.

Discussion

Iesaka and colleagues[1] reported that adenosine-sensitive AT originates near the AV node and is a reentry mechanism. The response to adenosine indicates the involvement of calcium channel–dependent tissues, such as the AV ring, which has a structure similar to that of the AV node, in the SCZ of the AT circuit.[6] Yamabe and colleagues[11] presented evidence of manifest entrainment and successful termination of AT via radiofrequency application. Radiofrequency was strategically applied between the EAS and various entrainment pacing sites in the right atrium, including the RA appendage, high anterolateral and high posteroseptal regions, and cavotricuspid isthmus, without inducing AV block.[11] Yamabe and colleagues[12] recently demonstrated manifest entrainment and orthodromic capture from a site posterior to the EAS. This indicates that the SCZ is oriented toward the noncoronary cusp (NCC) and assures successful ablation from the NCC.[12]

In our patient, RA-EAS was captured antidromically from the high posteroseptal right atrium. This pattern suggests a potential lack of efficacy in treatments targeting the NCC. Furthermore, orthodromic capture of the RA-EAS from the distal CS indicated that the SCZ of the AT circuit was probably positioned more toward the left atrium, across the septum. Based on these observations, a transseptal approach was performed, leading to the successful and safe treatment of AT. Ablation was performed 7 mm away from the LA-EAS toward the distal CS electrode. Regarding the energy used for ablation, cryomapping may help to identify safe and effective ablation sites, as it allows to estimate the therapeutic effect, while lesions near the AV node are reversible. In the present case, ablation of the anterior septum of the left atrium was required, so cryoablation was performed considering the risk of AV block.[13]

This case has some limitations. The patient had a history of stroke, which made us hesitant to map the NCC via a transaortic approach. Additionally, we did not perform a detailed entrainment pacing within the left atrium, which could have allowed the estimation of the exact length of the SCZ. The NCC approach can be used to successfully treat tachycardia originating from the anterior septum of the mitral annulus because of its proximity to the left anterior septum of the atrium.[14] However, if the tachycardia is recurrent or requires prolonged ablation via the NCC, it is important to consider the possibility of an LA tachycardia circuit.

Conclusion

Among the adenosine-sensitive ATs originating near the His bundle, there are rare cases of anterior septal origin of the

mitral annulus. Manifest entrainment between the distal CS electrode and the earliest activation site of the right atrium is important for its diagnosis and for identifying the direction of the slow conduction zone.

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References

1. Iesaka Y, Takahashi A, Goya M, et al. Adenosine-sensitive atrial reentrant tachycardia originating from the atrioventricular nodal transitional area. J Cardiovasc Electrophysiol 1997;8:854–864.
2. Horie T, Miyauchi Y, Kobayashi Y, et al. Adenosine-sensitive atrial tachycardia originating from the proximal coronary sinus. Heart Rhythm 2005;2:1301–1308.
3. Wang Z, Ouyang J, Liang Y, et al. Focal atrial tachycardia surrounding the anterior septum: strategy for mapping and catheter ablation. Circ Arrhythm Electrophysiol 2015;8:575–582.
4. Sakai S, Fujimoto H, Nakai T, Doi N, Suzuki M. Adenosine-sensitive atrial tachycardia originating from the para-Hisian region with the entrance of a slow conduction zone at the noncoronary aortic sinus. HeartRhythm Case Rep 2020; 6:448–452.
5. Bohora S, Lokhandwala Y, Sternick EB, et al. Reappraisal and new observations on atrial tachycardia ablated from the non-coronary aortic sinus of Valsalva. Europace 2018;20:124–133.
6. Yamabe H, Okumura K, Morihisa K, et al. Demonstration of anatomical reentrant tachycardia circuit in verapamil-sensitive atrial tachycardia originating from the vicinity of the atrio-ventricular node. Heart Rhythm 2012; 9:1475–1483.
7. Inagaki D, Hojo R, Fukamizu S, Sakurada H, Hiraoka M. Adenosine-sensitive atrial tachycardia originating from the anterior mitral annulus. HeartRhythm Case Rep 2018;4:542–544.
8. Nakamura K, Sasaki T, Minami K, Kishi S, Take Y, Naito S. An unusual location of the origin of an adenosine-sensitive atrial tachycardia: the lateral mitral annulus. J Cardiol Cases 2021;24:75–78.
9. Maruyama M, Kobayashi Y, Miyauchi Y, et al. The VA relationship after differential atrial overdrive pacing: a novel tool for the diagnosis of atrial tachycardia in the electrophysiologic laboratory. J Cardiovasc Electrophysiol 2007; 18:1127–1133.
10. Maruyama M, Yamabe H, Takatsuki S, et al. Last entrainment sequence: a novel diagnostic technique for atrial tachycardia mimicking other supraventricular tachycardias. JACC Clin Electrophysiol 2022;8:1289–1300.
11. Yamabe H, Kajiyama K, Soejima T, et al. Comparison of the catheter ablation outcome in patients between targeting the entrance and exit of the reentry circuit in verapamil-sensitive atrial tachycardia originating from the atrioventricular-node vicinity. Heart Vessels 2021;36:1201–1211.
12. Yamabe H, Soejima T, Kajiyama K, et al. Efficacy of catheter ablation from the noncoronary aortic cusp of verapamil-sensitive atrial tachycardia arising near the atrioventricular node. Heart Rhythm 2022;19:719–727.
13. Okishige K, Shigeta T, Nishimura T, et al. Cryofreezing catheter ablation of adenosine triphosphate sensitive atrial tachycardia. J Cardiovasc Electrophysiol 2019; 30:528–537.
14. Mori S, Shivkumar K. *Atlas of Cardiac Anatomy*. Digital Edition 2022;68–71.