More than meets the eye: Atrial fibrillation conversion pause with a twist

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Introduction

The Cox-maze procedure was developed in 1987 to achieve a reduction in atrial fibrillation (AF) by performing surgical scars in both the left (LA) and right atrium (RA).[1] Since then, the procedure saw several modifications designed to improve results. Still, advances in catheter-based technologies and patient preference for minimally invasive surgeries have made stand-alone Cox-maze procedures rare. However, this technique is still preferred in patients undergoing open heart surgery for valvular disease or coronary artery disease with a previous history of AF. Owing to the surgical lesion set in both the RA and LA, a few studies have described the presence of both inter- and intra-atrial dissociation immediately after a Cox-maze procedure.[2,3] This phenomenon may be important to recognize, as it can substantially impact patient management.

Herein, we describe a patient referred for management of AF years after a Cox-maze procedure and tachy-brady syndrome who was found to have dual atrial rhythm, which was important to recognize prior to permanent pacemaker implantation.

Case report

A 79-year-old woman with a past medical history of hypertension, hyperlipidemia, persistent AF (diagnosed in 2004) status post Cox-maze procedure in 2012, and mitral valve repair and later mitral valve replacement was referred to electrophysiology for management of her AF. The patient had severe, symptomatic mitral regurgitation from mitral valve prolapse with concomitant AF, for which she underwent mitral valve repair, Cox-maze procedure, and left atrial appendage ligation procedure at an outside institution (Figure 1; illustration of surgery). To this end, the surgeon performed a left atriotomy and used the cryoprobe to encircle the pulmonary veins; this included lesions from the left atrial appendage and the superior portion of the left atriotomy incision. Furthermore, a vertical lesion set was created to connect the inferior pulmonary vein to the middle aspect of the posterior mitral valve annulus. For the RA, the surgeon amputated the right atrial appendage and made a superior to inferior vena cava lesion; this lesion set was then also connected to the posterior aspect of the tricuspid valve. And finally, a lesion set was made connecting the medial amputated right atrial appendage to the anterior junction of the anterior and septal leaflets of the tricuspid valve. Postoperatively, the patient was noted to recover an atrial rhythm, which was thought to be sinus. A few months later, she underwent mitral valve replacement secondary to failed mitral valve repair.

About 8 years later, the patient was referred to us for management of her AF and concern for tachy-brady syndrome. She had previously undergone multiple cardioversions but she rapidly regressed back into AF. Medical therapy with amiodarone and metoprolol was challenging because of patient-reported bradycardia and pauses up to 5 seconds. The patient complained of exertional fatigue

KEY TEACHING POINTS

- A significant consequence of Cox-maze surgery can be dual atrial rhythm, which may not be recognized until years after the original procedure. This may result in areas of the atrium being isolated.
- Dual atrial rhythm may be identified via 12-lead electrocardiogram or extended rhythm monitoring.
- In patients undergoing pacemaker implantation who may have dual atrial rhythms, careful mapping may need to be done to avoid implantation of an atrial lead in isolated atrial tissue.

KEYWORDS Atrial fibrillation; Surgical ablation; Pacemaker; Cox-maze; Mitral valve surgery
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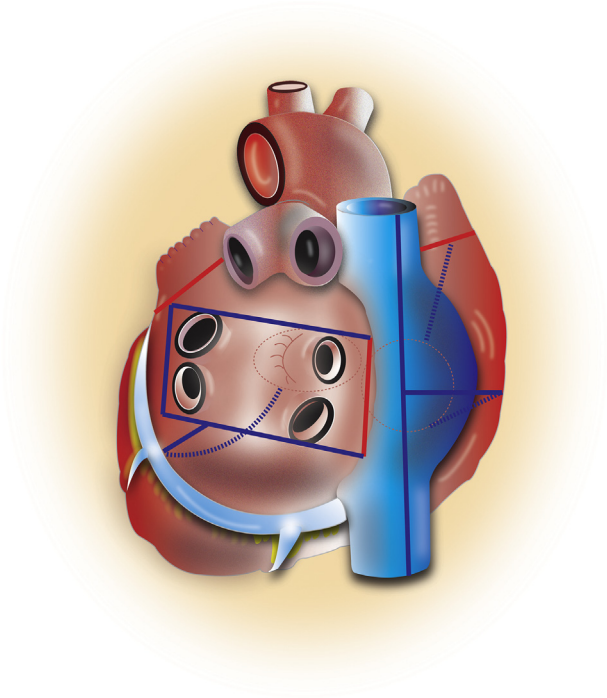

Figure 1 Graphic illustration of Cox-maze lesions that were done at the time of mitral valve surgery for patient's atrial fibrillation.

and dyspnea associated with AF paroxysms; thus, she expressed her preference to restart an antiarrhythmic medication as soon as possible to achieve better rhythm control. Her presenting electrocardiogram showed low-amplitude p waves (best seen in lead V_1 in Figure 2A) likely secondary to her Cox-maze procedure with ventricular bradycardia likely representing 3:1 atrial tachycardia. Given her reported history of "conversion" pauses and bradycardia, the patient underwent a wearable remote monitor to better quantify these phenomena (tracings obtained by outside institution, Figure 2B). Her wearable monitor showed frequent episodes of AF with superimposed nonconducting p waves. After each spontaneous AF termination the pre-existing sinus p waves continued, but failed to conduct to the ventricle; instead, a junctional escape rhythm ensued. To explain this observation, we postulated the presence of 2, mutually independent atrial zones. The first atrial zone retained its connection to the atrioventricular (AV) junction and served as the substrate for AF. Spontaneous cardioversion resulted in atrial standstill in this atrial zone, causing a junctional escape to take over. On the other hand, the patient's sinus node remained active but was confined to a second atrial zone with no access to the AV junction. Therefore, the observation can be summarized as a pseudo-AV block with the sinus node unable to conduct to the ventricle and atrial standstill in the conducting portion of the RA.

Given these findings and ongoing symptoms, the patient was brought to the electrophysiology lab for implantation of a dual-chamber pacemaker. On presentation, her (dominant) underlying rhythm was AF, but DC cardioversion had to be deferred because of subtherapeutic international normalized ratio. Instead, we proceeded directly with pacemaker implant, paying extra attention to the location of the RA lead. Local atrial electrograms were recorded through the lead from different locations of the RA. Figure 3A shows that AF was recorded on the RA septum, while sinus electrograms were observed on the lateral wall. The lead was placed in the RA septum (Figure 3B) to allow for future RA pacing, with adequate AV conduction. The patient was discharged the next day with plans for follow-up for a cardioversion after maintaining a period of therapeutic anticoagulation.

The patient presented 4 weeks later and received a synchronized cardioversion for AF. The device interrogation revealed normal-functioning RA and right ventricle leads with an RA sensing amplitude of 0.9 mV and capture threshold of 0.9 V at 0.4 ms. Most importantly, during testing atrial lead capture, there was adequate AV conduction with atrial pacing.

Discussion

We describe the case of a patient who previously underwent a Cryo-maze procedure and subsequently developed dual atrial rhythm, with an isolated sinus node that was recognized many years after the original surgery. Recognition of this phenomenon was important in guiding the placement of the RA lead into an atrial zone with presumed access to the AV junction.

Dual atrial rhythm after Cox-maze is an uncommon but well-described phenomenon. Do and colleagues[2] described interatrial and intra-atrial dissociation in a small cohort of patients ($n = 7$) undergoing a post–Cox-maze electrophysiology study owing to concern for complete heart block or ventricular tachycardia. Similar to our case, the majority of these study subjects exhibited dissociation of the posterolateral RA from the rest of the RA, resulting in an electrical isolation of the sinus node. However, it should be noted that these patients were studied in the immediate postoperative period, in stark contrast to our patient, in whom this phenomenon was recognized almost a full decade after the original Cox-maze procedure. It is not clear what specific surgical lesions are responsible for atrial dissociation. Notwithstanding, Do and colleagues' study proposed that extensive surgical lesion sets and the use of an extended trans-septal atriotomy approach may portend a risk factor.[2] However, our patient's 9-year-old surgical records implied that only a standard RA lesion set was used; moreover, it is unknown whether the isolation of the lateral wall happened postoperatively or required years of structural remodeling and fibrosis before materializing.

Intra-atrial dissociation has also been described in other clinical scenarios, including in recipients of biatrial anastomosis orthotopic heart transplantation[4,5] and in patients with pre-existing RA scarring (usually postsurgical), who then undergo extensive catheter-based ablation of the lateral RA scar.[6] Indeed, the latter group frequently require septal RA pacing to avoid unnecessary ventricular pacing. As

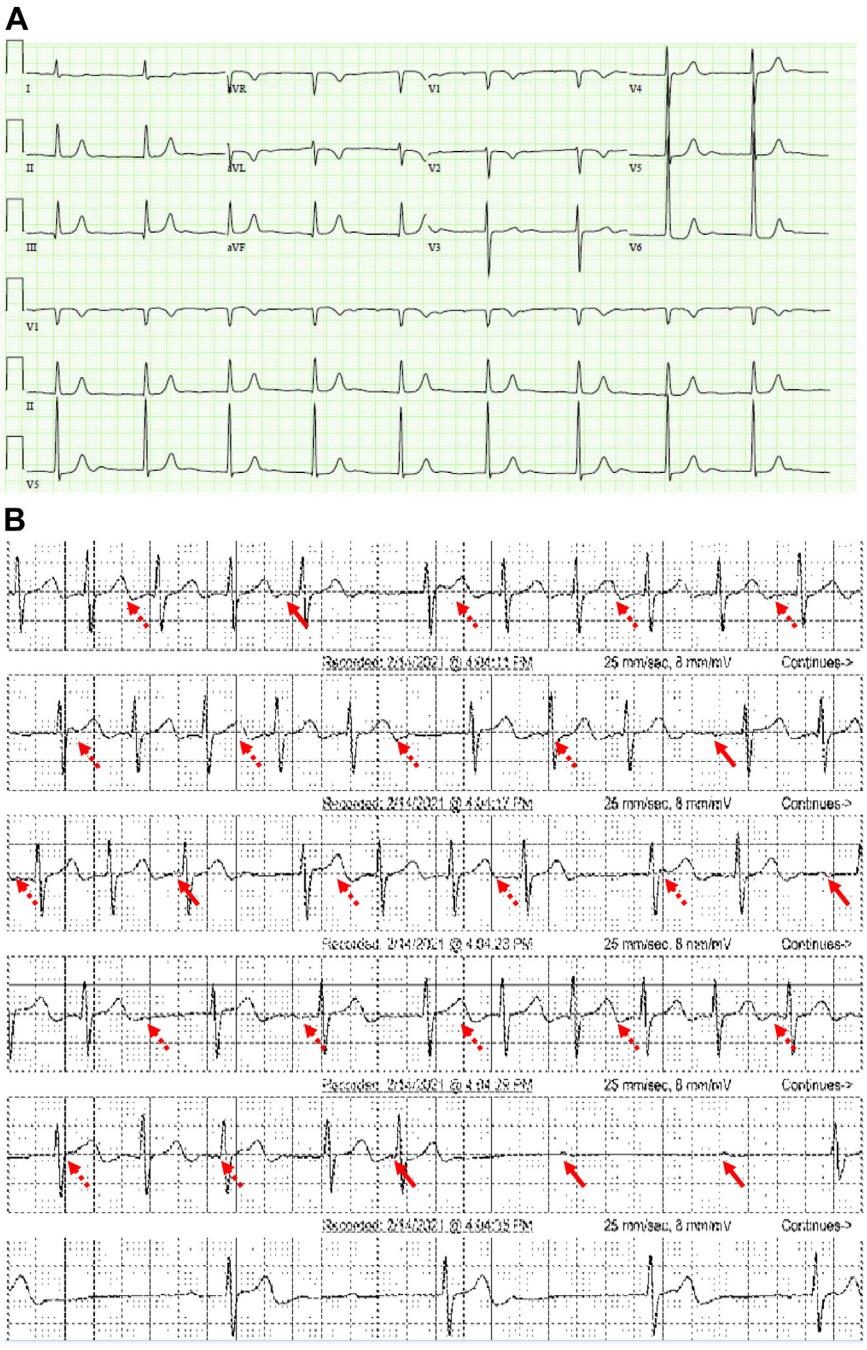

Figure 2 **A:** Presenting electrocardiogram in the outpatient clinic that showed likely atrial tachycardia with 3:1 ventricular conduction. **B:** An example of a "conversion pause" that was frequently captured by the patient's wearable monitor (tracing transmitted from outside hospital). The initial rhythm in this tracing is atrial fibrillation (AF) with irregular ventricular response. However, there appear to be superimposed, dissociated sinus p waves (solid and dashed red arrows point to directly observed p waves or to their expected location when extrapolated using a fixed sinus cycle length, respectively). Following a spontaneous AF conversion (fourth strip), the sinus p waves continue, but they fail to conduct to the ventricle. A junctional escape rhythm eventually ensures. Similar episodes were observed multiple times during the monitored period.

intra-atrial dissociation may be seen in other aforementioned conditions in addition to Cox-maze procedure, electrophysiologists should be vigilant that this condition may exist. Once again, this observation highlights the importance of mapping the RA in patients with suspected dual atrial rhythms with pseudo-AV block.[6]

Conclusion

We present a case of a patient with dual atrial rhythm and pseudo-AV block diagnosed years after the Cox-maze procedure. Recognition of this diagnosis was important in guiding RA lead placement during subsequent permanent pacemaker implantation.

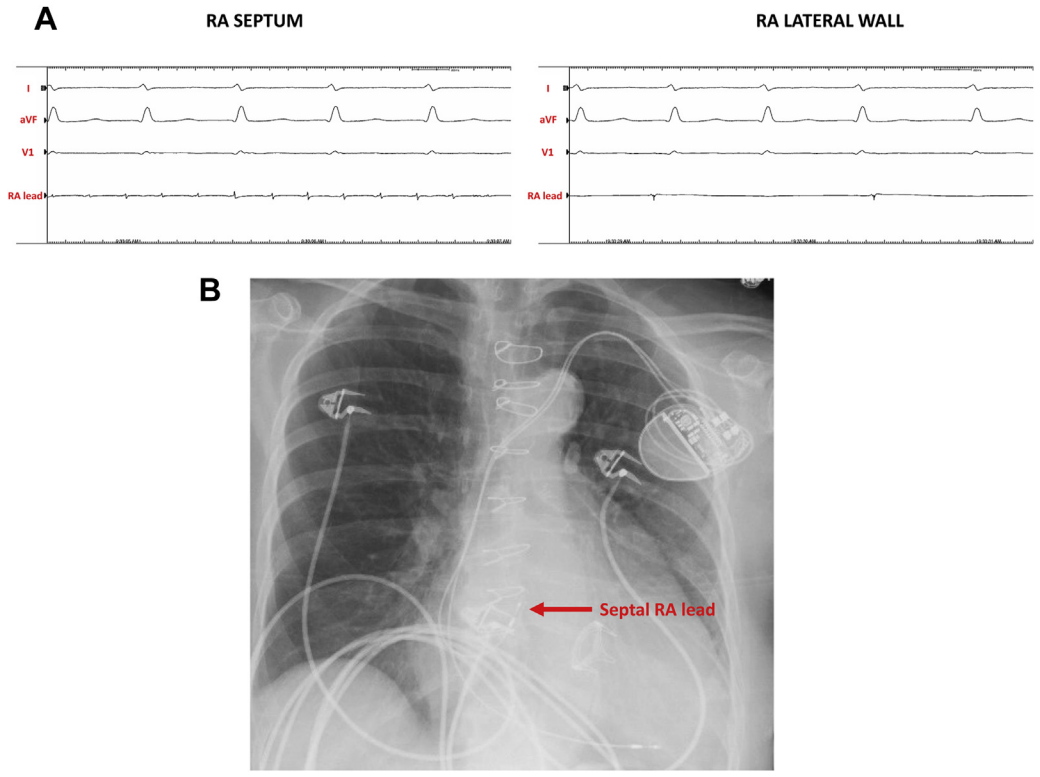

Figure 3 **A:** Intracardiac electrograms collected by the right atrial (RA) lead before active fixation. The septum is in atrial fibrillation and conducts to the ventricle. While the lateral wall is in sinus rhythm, it fails to conduct to the ventricle (pseudo-AV block). **B:** Posteroanterior chest radiograph was obtained after permanent pacemaker implant, detailing the septal position of the RA lead.

References

1. Cox JL, Schuessler RB, Boineau JP. The development of the Maze procedure for the treatment of atrial fibrillation. Semin Thorac Cardiovasc Surg 2000;12:2–14.
2. Do U, Nam G-B, Kim M, et al. Inter/intra-atrial dissociation in patients with maze procedure and its clinical implications: pseudo-block and pseudo-ventricular tachycardia. J Am Heart Assoc 2020;9:e018241.
3. Eleid MF, Dearani JA, Shen W-K. Isolated atrial lead conduction delay following right atrial radiofrequency maze procedure. ISRN Cardiol 2011;2011:475796.
4. Gorla SR, Raja KR, Sokoloski MC, Swaminathan S. Sinus node dysfunction masquerading as complete atrioventricular block in the setting of atrial parasystole after heart transplantation. J Electrocardiol 2018;51:555–558.
5. Lowery CM, Lewkowiez L, Sauer WH. P-wave rejection in a transplanted heart. Ann Noninvasive Electrocardiol 2011;16:308–310.
6. Markowitz SM, Choi DY, Daian F, et al. Regional isolation in the right atrium with disruption of intra-atrial conduction after catheter ablation of atrial tachycardia. J Cardiovasc Electrophysiol 2019;30:1773–1785.